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PROBLEMS IN THE STUDY OF METEORITES*†

W. F. FOSHAG,
Curator, Mineralogy and Petrology, U. S. National Museum, Washington, D.C.

INTRODUCTION

The fall of meteorites from heaven has been a recognized phenomenon for many centuries. It is stated that the first record is one among the Chinese 6,000 years ago. The Persians, Greeks and Romans considered them as messages from the Gods, built temples over them and revered them. During the Middle Ages they were looked upon as omens of evil, bewitched personages and similar prodigies.

Later, a belief in the possibility of stones fallen from heaven brought forth only ridicule, even from scientific men. Stütz, a famous Austrian mineralogist, remarked, concerning the reported fall of a mass of pure iron at Agram in 1751, that "in our times it would be unpardonable to consider such fairy tales even probable." The German physicist, Chladni, in 1794 first challenged this disbelief and even suggested that meteorites are, in fact, "world fragments." Mineralogists now recognized them for what they are—celestial rocks—rocks with many unusual characters, but amenable to study by the same methods as the better known terrestrial rocks.

The earliest preserved meteorite is one that fell at Ensisheim, Germany, on November 16, 1492. Since then 1,250 distinct meteorites have been recovered, some only as a small individual of but a few grams, others very much larger, even weighing tons. Some reach the earth in thousands of fragments as a shower of stones during a single fall, as those of Pultusk in 1868, when 100,000 fragments are said to have fallen. These 1,250 meteorites can be classified into three rather distinct groups, one made up predominately of stony matter, called aerolites, another almost completely metallic in character, called siderites, and the intermediate forms of about equal proportions of stony and metallic matter, called siderolites. The actual proportion of metallic to stony meteorites must be low, for of all the known meteorites actually seen to fall, only 23 are siderites, against several hundred aerolites. The metallic nature of the siderites attracts attention and leads to the more frequent discovery of unwitnessed falls, while the stony meteorites are more easily overlooked.

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MINERALS OF METEORITES

In all, 14 essential minerals have been found in meteorites; the two iron-nickel alloys: kamacite and taenite; the pyroxenes: enstatite, hypersthene, clinoenstatite, clinohypersthene, diopside, augite and pigeonite; the olivines: chrysolite and forsterite; and the feldspars: anorthite, oligoclase and maskelynite.

Characteristic accessory minerals are the two forms of carbon, diamond and graphite; the carbides cohenite and moissanite; the sulfides troilite, daubréelite, oldhamite and osbornite; the phosphide schreibersite and the phosphate merrillite. Quartz and tridymite are exceptionally rare. From the chemical nature of these minerals, one can readily perceive that meteorites have formed in an environment free of water and deficient in oxygen.

STONY METEORITES

Stony meteorites have the mineralogical characters of our terrestrial rocks, and, with the exception of a few accessory minerals, are made up of species not uncommon in our earth. Two types of stony meteorites can readily be distinguished.

The common type of stony meteorites is an aggregate of small shot-like bodies, shaped like öolites. These are called *chondrules* and the rock composed of them *chondrites*. These chondrules are made up either of olivine, enstatite or hypersthene. The important structural and mineralogical types are: (1) barred olivine chondrule with dark glass, (2) porphyritic olivine in a dark glassy base, and (3) radiated enstatite or hypersthene, often with a peripheral or eccentric origin of radiation. Obviously these chondrules have crystallized rapidly from molten droplets of fused silicates. These meteorites may also contain grains of feldspar and dark glass, and they always carry irregular blebs or films of nickel-iron and troilite. The nickel-iron is never found within the chondrules, but occasionally surrounds some. Usually, it is sporadically distributed through the brecciated mass, as if it were a later introduction. Meteorites, like N'gawa and Warrentown, are made up almost entirely of these concretionary bodies. In others the chondrules are largely broken and comminuted.

What is the origin of these strange chondrule bodies? Sorby likened them to a fall of fiery rain and no better explanation has yet been offered. But what were the circumstances of this fiery rain, if such it was? No terrestrial volcanoes yield, or have yielded, such products. Other explanations have been discarded but some promising theories have not been adequately explored. The agglomeratic nature of chondritic meteorites leaves little doubt that they are volcanic tuffs. Many of them show evidences of reheating, in the transition of their minerals, in fused black veins, thermometamorphism and other features.

The universal presence of metallic nickel-iron and of troilite introduces further difficulties of interpretation. There is an apparent relationship between the iron content of the silicates and of the alloys. It must be admitted that, in general, as the iron content of the silicates increases, that of the nickel-iron alloys decreases, as if there was a partition of the iron between the silicate and the metallic portions. Yet there is strong evidence that the nickel-iron is a later introduction, not only later than the crystallization of the chondrules, but after their brecciation. In the unique Cumberland Falls meteorite, obviously made up of fragments of two totally different types of rock, the metallic iron follows the configuration of the fragments as a tenuous film of metal.

A second type of stony meteorite is completely crystalline, like terrestrial rocks, and because they are without chondrules, are called achondrites. Among the achondrites we recognize the types in the table below.

ACHONDRITES AND THEIR TERRESTRIAL EQUIVALENTS

Achondrite	Minerals	Terrestrial Rock
Aubrite	enstatite	enstatolite
Diogenite	hypersthene	hypersthenite
Chassignite	olivine	dunite
Angrite	augite	augitite
Amphoterite	olivine and hypersthene	harzburgite
Nakhlite	olivine and diopside	lherzolite
Eucrite	anorthite and pigeonite	diabase

All of these carry as accessory minerals, nickel-iron alloys in varying amounts.

It is evident that the achondrites correspond to basic terrestrial rocks. Even as the better known earthly basic rocks offer problems of genesis, so their celestial analogues present difficulties to an even greater degree. How can such rocks form from melts, as they apparently appear to have done? In addition, the presence of iron minerals, like the nickel-iron alloys and the iron subsulfide troilite, introduces further problems. For instance, the aubrites consist of pure magnesian enstatite, free from any iron content, as is always found in terrestrial rocks, yet free metallic iron is always present. Have they crystallized with a deficiency of oxygen so that only the magnesium and the silicon have been satisfied, without even a trace in excess to join with the iron? Or have they crystallized from pure magnesium silicate melts, and the iron introduced later?

Some of these achondrites show normal unaltered crystallinity. Many others show varying degrees of fracturing, even to extreme cataclastic granulation.

Iron Meteorites

The second group of meteorites, the siderites, are heavy, compact masses of metal, alloyed iron and nickel, sometimes in huge masses, like Hoba West, weighing sixty tons. In chemical composition they range from 94 per cent iron and 6 per cent nickel, to 70 per cent iron and 30 per cent nickel; in a few doubtful cases they are even more nickel-rich. Accessory constituents are few; troilite, a subsulfide of iron; daubréelite, an iron-chromium sulfide; schreibersite, a nickel-iron phosphide; carbon, diamond and cohenite, the iron carbide, and occasionally magnesium silicates. A small amount of cobalt, usually not exceeding one per cent is always present and there are often traces of platinum and copper. Geophysicists tell us that the core of our earth is probably of a similar nature.

If these iron meteorites are polished and appropriately etched several kinds of internal structures can be developed. The structure can be correlated, in a general way, with the chemical composition of the meteorite.

One class of iron with a nickel content of about 6 per cent is characterized by a well defined cubic cleavage and long, narrow lines, called Neumann lines, that follow the twinning directions of cubic iron. These irons are called hexahedrites.

A second class shows a beautiful basket-weave pattern, resembling the twinning shown by some minerals. The constituent lamellae are arranged parallel to octahedral planes and these meteorites are, therefore, called octahedrites. Close examination reveals two constituents. The coarser lamellae, similar in nature to the iron of hexahedrites, is called kamacite, and a thinner bordering plate of a higher nickel content is called taenite. Often an interstitial eutectic-like mixture of kamacite and taenite is apparent and is called plessite.

The octahedrites range in nickel content from 6–14 per cent, and the meteorites rich in nickel show finer and usually more distinct structures. This is the commonest class of iron meteorite of which characteristic examples are Canyon Diablo, Arizona, and the huge Bacubirito of Mexico,

A third class shows no regular structure of the iron. It may be dense.

felted, flecked, granular or some other irregular fabric. These meteorites are high in nickel, from 15 to 30 per cent. Because of their lack of regular structure they are called ataxites.

The structure of many meteorites may be changed or modified by heating. Hexahedrites become granular, transforming into granular ataxites. Octahedrites lose their regular structure passing into metabolites. Some iron meteorites are found with these secondary structures naturally developed.

The nature of kamacite is now rather well understood. It is α-iron, the body centered form, stable at a low temperature and can carry a maximum of 6 per cent of nickel in solid solution. The kamacite of octahedrites and the iron of hexahedrites are entirely similar. Taenite is much richer in nickel. It is γ-iron, the face centered form, but its exact chemical composition is doubtful. There are some who believe it is an intermetallic compound, Fe_3Ni, but it is generally considered as an alloy of variable composition. The difficulty lies partly in the heterogeneous nature of the samples of taenite analyzed, and probably in the fact that taenite has no fixed composition but can vary within fairly wide limits.

One might expect that a study of the equilibrium relationships of the system iron-nickel, as determined by the physical chemist, would reveal the relationships and origin of these structures without difficulty. But, unfortunately, extraordinary sluggish transitions in significant regions of the diagrams have led to diverse and erratic results. The two forms of iron involved in meteoritic iron structures are α-iron and γ-iron, but intermediate metastable forms may also be involved, if complete equilibrium is not attained. A critical study of meteorite structures may well decide what is the true relationships in the Fe-Ni system and help to define more accurately the composition of the phase fields.

The kamacitic nature of the hexahedrites and their origin through the normal transformations on cooling of nickel-iron of appropriate composition can be accepted as well established. Their only unusual feature is their tremendous grain size. The possible influence of strains or stresses, which have been shown to develop large single crystals from fine grained aggregates, must be considered in this connection. Hexahedral patterns can be induced in artificial iron by violent disruption, as in explosions, and some similar influence may have been active in inducing the characteristic Neumann lines of meteorites. The granulation of hexahedrites by secondary heating accounts for the so-called "low-nickel ataxites."

The structure of the octahedrites, on the other hand, has aroused a great deal of speculation and diverse theories have been offered to explain it. The theory of the origin of Widmanstätten figures is based on the slow cooling of alloys with more than 6 per cent of nickel, with the primary formation of γ-iron. At lower temperatures a γ to α transformation takes place in the solid state, and since the α form (kamacite) has a lower nickel saturation composition than the original alloy, there results a rejection of a high-nickel phase, taenite. When a solid solution, which is stable at high temperatures, precipitates a new phase on cooling, this new phase is deposited in such a way that its lattice bears a definite crystallographic relationship to the lattice of the parent solid solution. This relationship is familiar to the mineralographer in many so-called ex-solution patterns in sulfide minerals. In the case of the Widmanstätten structure in meteorites the dodecahedral plane of kamacite parallels the octahedral plane of taenite. The presence of the eutectic-like plessite has received no adequate explanation.

There is the problem of whether the Widmanstätten structure results from extremely slow cooling within the central core of some body, as our own earth; or by repeated annealings in the passage of the meteorite about the sun; or by some other treatment.

No well established explanation for the various structures of the high-nickel ataxites has been proposed. We are still quite ignorant of the forms of iron that are involved, nor have we determined the role of the frequently occurring phosphides on the structure. Some ataxites may represent pure or nearly pure taenite; others, of lower nickel content, may prove to be metastable forms of iron, or products of incomplete transformation.

STONY-IRON METEORITES

The third class of meteorites is an intermediate type, consisting of both metallic and stony elements in about equal proportions, and are called siderolites or lithosiderites. These fall into two general categories: (1) those carrying olivine, bronzite and sometimes plagioclase in an irregular groundmass of iron, usually of granular texture; and (2) large phenocryst-like olivine crystals in a mesh of octahedral iron. The first group, the mesosiderites, can be considered as stony meteorites with an unusual abundance of iron. The best known meteorite of this type is the Estherville fall. The second class, the pallasites, are a distinct group with unusual structure and relationships.

The olivine of the pallasites may be polyhedral or rounded crystals as in Krasnojarsk, or they may be angular, broken fragments as in Eagle Station, or strongly fractured individuals of a sandy texture as in Imilac. In spite of the intimate association of the olivine with metallic nickel-iron, it is free of nickel and relatively low in ferrous oxide. The problem here is somewhat similar to the apparent anomalous relationship of magnesium silicates and metallic iron in the stony meteorites. The "porphyritic" olivines of the pallasites may be considered as an early crystallization in a matrix of iron. But what about the brecciated olivine like that of Eagle Station? Is the iron a later introduction into a brecciated mass of olivine? Or has the olivine been crushed with a concomitant flowage of the metal?

As in the stony meteorites, a varying degree of oxidation seems apparent. The siderophyr of Steinbach, containing pyroxene and tridymite can be considered as least oxidized. Apparently only enough oxygen was available to combine with magnesium, silicon and a small amount of iron to form the metasilicate pyroxene, leaving, however, an excess of silica unsatisfied. The mesosiderites with both pyroxene and olivine belong to an intermediate step, in which oxidation of the iron did not proceed far enough to convert all the metasilicate into the orthosilicate. In the pallasites sufficient iron is oxidized to induce the formation of the orthosilicate alone. Curiously enough the balance of the elements is inordinately fine, there being no excess of basic elements (other than nickel and iron) or of oxygen, to form more than insignificant quantities of oxides or spinels, a most inexplicable relationship. The rare iron-nickel bearing dunites, and finally the normal dunites, are terrestrial extrapolations of this series.

AGE OF METEORITES

Some attention has been given to the determination of the ages of meteorites by the helium method, but the results achieved so far are erratic. But no determinations yet made show an age greater than the age determined for our earth. Since meteorites show indubitable evidence of later heat treatment, sometimes of successive heat treatments, it is perhaps more logical to assume that the erratic results obtained are due to the expulsion of the helium. If, because of this removal of helium, these determinations do not give us the ultimate age of the meteorite, they may, under the assumption that all the helium is expelled, give us the time of some important incident in the bodies' history, as, perhaps its last approach near the sun. This assumption is more likely valid for stony meteorites, which lose their helium freely, than for iron meteorites, which hold it more persistently. Reliable data are still very meager, but eventually some interesting correlations may be discovered.

ORIGIN

From whence come these celestial wanderers? And what is their origin? The hypothesis of Chladni, that they are aggregates of matter, the "Urmaterie" from which world bodies might form, still attracts some followers. "The Vermin of the Universe" they have been called. Petrologic evidence, however, points strongly to the fragmentation of a larger astronomical body. One of the difficulties in postulating a common origin for all meteorites is to reconcile the evidence of slow and prolonged heat treatment in the iron meteorites, and the obvious rapid congelation of the stones.

All that we can now say, with reasonable certainty, is that meteorites are basic rocks that have crystallized from molten material in which water was absent and oxygen deficient; that some, the siderolites and siderites, resulted from slow and prolonged cooling, and others, the aerolites, cooled rapidly. There is abundant evidence of tremendous disruption and fragmentation, often followed by later thermometamorphism. It is difficult to avoid the conclusion that they are the debris of some celestial catastrophe.

Whether they were formed at the birth of the moon, the destruction of the missing planet of Olber's, or the dissolution of some other planetary or cosmic mass, I can leave to the decision of the astronomers. It is the mineralogist's province to determine the character of the original body, whatever it may have been, and to follow as far as possible the mutations of its fragments until they come to rest upon our earth. And while the mineralogist may not definitely point to the ultimate origin of these celestial "tramps," he can, at least narrow the field of speculation.

WHITLOCKITE: A NEW CALCIUM PHOSPHATE, $Ca_3(PO_4)_2$

CLIFFORD FRONDEL,
Harvard University, Cambridge, Massachusetts.[*]

ABSTRACT

Whitlockite is a tricalcium phosphate, $Ca_3(PO_4)_2$. Rhombohedral, probably scalenohedral—$\bar{3}$ $2/m$, with $a:c=1:3.547$. Habit rhombohedral $\{01\bar{1}2\}$, with subordinate $\{0001\}$, $\{10\bar{1}4\}$, $\{11\bar{2}0\}$. Structure cell (in hexagonal coordinates): $a_0=10.25\pm0.03$, $c_0=36.9\pm0.1$; $a_0:c_0=1:3.600$; $a_{rh}=13.65$, $\alpha=44°\ 6\frac{1}{2}'$. Cell contents in the rhombohedral unit $Ca_{21}P_{14}O_{56}$. Space group probably $R\bar{3}c$. No cleavage. Hardness 5. Specific gravity 3.12 (obsvd.), 3.19 (calc.). Colorless and transparent. Uniaxial negative, with $\omega=1.629\pm0.002$ and $\epsilon=1.626\pm0.002$ (for Na).

Found as a late hydrothermal mineral in granite pegmatite at the Palermo quarry, near North Groton, New Hampshire, in the following association and sequence: whitlockite and quartz—rhodochrosite—apatite—zeolite. Whitlockite is structurally distinct from graftonite, caryinite, fillowite and apatite. Named in honor of Herbert P. Whitlock, Curator of Minerals and Gems in the American Museum of Natural History.

INTRODUCTION

The new mineral here described was found in the Palermo pegmatite quarry on Bald Face Mountain, near North Groton, Grafton Co., New Hampshire. The writer is indebted to Prof. Charles Palache for the opportunity to examine the material, and to Mr. Harold J. Verrow, who found the first specimens, for guidance on a visit to the occurrence. The name whitlockite is proposed for the mineral in honor of Herbert Percy Whitlock, a former Secretary and President of the Mineralogical Society of America, and at present Curator of Minerals and Gems in the American Museum of Natural History.

CRYSTALLOGRAPHY

Occurs as coarse granular masses with small open cavities lined with crystals. The crystals range in size from about 1 mm. to 1.5 cm. along the *c*-axis. An embedded partially developed crystal measured about 3 cm. across a rhombohedral face. The crystals usually are simple rhombohedra with the form $e\{01\bar{1}2\}$, as shown in Fig. 1, but sometimes are modified by small faces of $c\{0001\}$ and $f\{10\bar{1}4\}$, as shown in Fig. 2. Many doubly terminated individuals were observed and no evidence was found of less than holohedral symmetry (rhombohedral scalenohedral—$\bar{3}$ $2/m$), although general forms are not present. The value for the $a:c$ ratio was obtained from the average of the best angular readings on $\{10\bar{1}4\}$ and

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[*] Contribution from the Department of Mineralogy and Petrography, Harvard University, No. 235.

$\{01\bar{1}2\}$. The form list as given in Table 1 is in conformity with the structural cell as determined by *x*-ray Weissenberg study.

The smallest of the single crystals on the specimens was examined by the Weissenberg *x*-ray method, using Cu radiation. The [0001] period proved to be extremely large. A 0-layer photograph taken about [0001] with a layer-screen slit opening of *ca.* 1.5 mm. registered both the 0-layer reflections and a number of additional reflections belonging to the 1-layer. All of the 0- and 1-layer reflections on this film were measured and plotted with a Z scale marked for $\beta=0°$. The 1-layer reflections were readily recognized on the projection by their slight inclination to the 0-layer net and by their geometrical relations, and proved to be offset $\frac{1}{3}$ of a net diagonal from those of the 0-layer. The direct lattice type is thus established as rhombohedral. Rotation, 0- and 1-layer photographs were also taken about the $[11\bar{2}0]$ axis. The 0-layer and especially the 1-layer films were not very satisfactory due mostly to the relatively large size of the crystal examined. The [0001] period appeared to be doubled on the 0-layer, indicating a glide plane with component $c/2$, but there is no

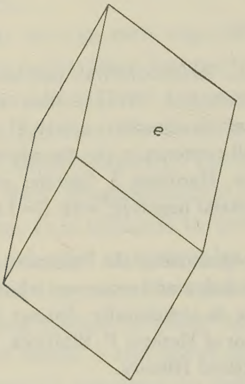

FIG. 1

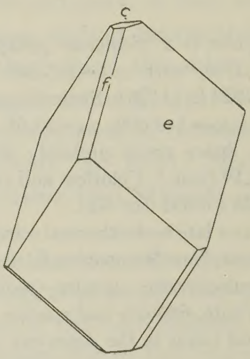

FIG. 2

TABLE 1. WHITLOCKITE: ANGLE TABLE

Hexagonal—*R*; scalenohedral—$\bar{3}$ $2/m$ (?)
$a:c=1:3.5473$ $p_0:r_0=4.0961:1$

Forms	ϕ	ρ	A_1	A_2
c 0001	—	0°00′	90°00′	90°00′
a $11\bar{2}0$	0°00′	90 00	60 00	60 00
f $10\bar{1}4$	30 00	45 41	51 43	90 00
e $01\bar{1}2$	−30 00	63 58½	90 00	38 54

certainty of this due to marked absorption effects. Admitting the validity of the glide and accepting the point-symmetry as holohedral, the space group is $D_{3d}^6 = R\bar{3}c$.

The following cell dimensions were obtained (in hexagonal coordinates):

$$a_0 = 10.25 \pm 0.03;\ c_0 = 36.9 \pm 0.1;\ a_0 : c_0 = 1 : 3.600;\ a_{rh} = 13.65;\ \alpha = 44^\circ 6\tfrac{1}{2}'.$$

The value for a_0 was calculated from the 0-layer about [0001]. The value for c_0 is taken from the 12th (36.88), 14th (36.94) and 16th (36.90) orders on the rotation picture about [0001]. The rotation value is preferred to those obtainable on the 0-layer photograph about $[11\bar{2}0]$ because of absorption and crystal-imperfection effects on this film. The value for c_0 and possibly also that for a_0 may be somewhat low. The cell contents in the hexagonal unit are $21(Ca_3(PO_4)_2)$, and are derived and itemized in Table 2. The difference between the calculated specific gravity of 3.19 and the observed specific gravity of 3.12, and the relatively low calculated cell contents as given in column 4, Table 2, indicate the calculated cell volume to be low.

PHYSICAL PROPERTIES

No cleavage was observed. Fracture is sub-conchoidal to uneven. Brittle. Hardness 5; it does not scratch apatite and is not scratched by apatite. Observed specific gravity is 3.12 ± 0.02 (Berman microbalance); calculated specific gravity $= 3.19$. Luster is vitreous, inclining to sub-resinous on fracture surfaces; the luster very closely resembles that of apatite. The mineral is colorless and transparent. The larger crystals and the fractured masses are white or grayish-white and are translucent *en masse*. Optically, uniaxial negative. Indices (for Na): $\omega = 1.629 \pm 0.002$ and $\epsilon = 1.626 \pm 0.002$. It does not fluoresce.

CHEMISTRY

Whitlockite is an anhydrous tricalcium phosphate, $Ca_3(PO_4)_2$, as shown by the analysis cited in Table 2. Small amounts of Mg ($Mg:Ca = 1:13$) and of Fe ($Fe:Ca = 1:31$) are present replacing the calcium. The role of the ferric iron reported is uncertain, but is included with calcium in the calculation of the cell contents. About one-third of the small amount of water present is lost upon short heating at 140° C. and all of it is considered to be non-essential. The water apparently has come from minute liquid-filled cavities scattered through the crystals and visible under moderate magnification.

Table 2. Analysis and Cell Contents of Whitlockite

	1.	2.	3.	4.	5.	
CaO	46.90	47.47	Ca 0.8465	53.8	55.6	63
MgO	2.53	2.56	Mg 0.0635	4.0	4.2	
FeO	1.91	1.93	Fe 0.0487	3.1	3.2	
Fe_2O_3	1.73	1.75	P 0.6509	41.4	42	
P_2O_5	45.68	46.23	O 2.5989	165.1	168	
Cl	tr.	tr.				
F	0.06	0.06				
insol.	0.51					
H_2O	0.48					
	99.80	100.00				

1. Analysis of whitlockite by F. A. Gonyer, October, 1940, on Harvard spec. no. 95031.
2. Analysis recalculated to 100 per cent after deduction of insoluble material and water.
3. Atomic proportions.
4. Actual number of atoms in the unit cell (hexagonal coordinates) calculated from the measured molecular weight of 6354.
5. Theoretical number of atoms in the unit cell for $21(Ca,Mg,Fe)_3(PO_4)_2$, with Ca:Mg:Fe =846:63:49.

Whitlockite does not appear to have any close relatives among either anhydrous or hydrous minerals of the $A_3X_2O_8$ type. Graftonite, $(Fe, Mn, Ca)_3(PO_4)_2$, is similar chemically. The optical and little known crystallographical properties of this species, however, indicate it to be monoclinic, and the x-ray powder pattern is quite different from that of whitlockite. The powder pattern of the orthorhombic mineral caryinite, $(Ca, Pb, Mn)_3(AsO_4)_2$ (?), is unlike those of whitlockite, graftonite and fillowite. Fillowite, $(Mn, Fe, Ca, Na)_3(PO_4)_2 \cdot H_2O$ (?), is described as monoclinic, pseudo-rhombohedral. The crystals closely simulate a steep rhombohedron terminated by $\{0001\}$, which is a habit typical of whitlockite. A type specimen (Yale 3093) of fillowite from Branchville, Connecticut, was examined for purposes of comparison. Optically this material was biaxial positive, with small 2V and with the acute bisectrix approximately perpendicular to the perfect cleavage ($=\{0001\}$ in rhombohedral pseudosymmetry). Indices: $\alpha=\beta=1.671\pm0.002$ and $\gamma=1.676\pm0.002$. These data confirm the data for fillowite given by Larsen (1921). The x-ray powder pattern is entirely different from that of whitlockite. A sample of alleged merrillite from the Waconda meteorite was found to have a powder pattern different from both whitlockite and apatite, but there is no certainty as to the validity of the specimen. The x-ray powder patterns of apatite and whitlockite also are completely different, as

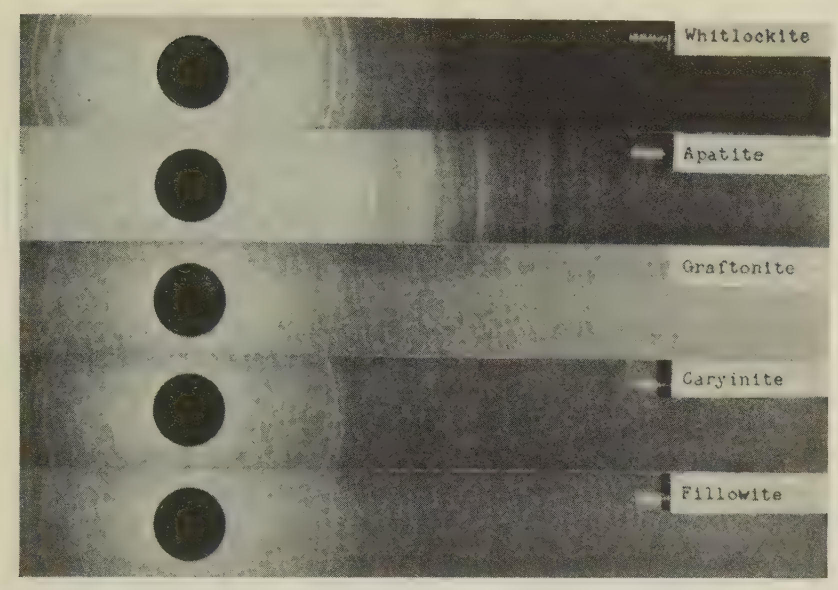

FIG. 3. *X*-ray powder photographs of whitlockite, apatite, graftonite, caryinite, fillowite. Cu radiation.

shown in Fig. 3, and there is no question but that the two species are structurally dissimilar. There is, however, a near identity in the physical properties of the two minerals, as is seen from the following tabulation:

	Whitlockite	*Apatite*
ω	1.629	1.633–1.644
ϵ	1.626	1.632–1.640
Hardness	5	5
Specific gravity	3.12	3.18±
Fracture	Sub-conchoidal to uneven	
Luster	Vitreous to sub-resinous	

Dimensionally, apatite and whitlockite compare as follows:

	Whitlockite	*Fluor-apatite*
Space group	$R\bar{3}c$ (?)	$C6_3/m$
a_0 (hex. coords.)	10.25	9.37 (∼10.25)
c_0	36.9	$6.88\left(\sim\frac{36.9}{6}\right)$

Occurrence and Association

Whitlockite was found as a few small masses on the waste heap of the Palermo quarry. The material was weathered and stained and disintegrated readily under the hammer. The principal constituent of the masses was whitlockite as granular aggregates, and as crystals lining cavities. No feldspar or mica was present on the specimens, and the relation of the whitlockite to the main pegmatite body is not known. The nature of the associated minerals suggests that the whitlockite was a late low temperature hydrothermal product.

Colorless to pale smoky, doubly terminated quartz crystals ranging from microscopic dimensions up to 2–3 mm. in size are scattered through the whitlockite and in part project out into cavities Rarely, small rhombohedrons of rhodochrosite occur perched upon whitlockite crystals and usually are slightly embedded in the surface of that mineral. Apatite is present as drusy crystals deposited upon whitlockite. In places the whitlockite was deeply etched and corroded before the apatite deposition. The apatite crystals range in size from about 0.2×0.5 mm. to 4×2 mm., and are inwardly colorless but outwardly have a pearly white zone with a brownish surface film. The last of the primary minerals to form was a zeolite in fibrous tufts and bundles and fan-like aggregates. The mineral is badly altered and chalky, and its identity is unknown. Thin brown and black crusts of hydrous iron and manganese oxides are present as weathering products. The sequence of deposition is:

whitlockite and quartz→rhodochrosite→apatite→zeolite.

The Palermo granite pegmatite was a large producer of muscovite for many years. The general geology of the occurrence and the quarry and underground workings have been described by Sterrett (1914). Details of the mineralogy are lacking, aside from the description by Berman (1927) of graftonite from this locality, and the following brief list of the more unusual minerals of the pegmatite may be of interest. Amblygonite was observed as pale yellow transparent platy crystals 1 to 5 mm. in width implanted on drusy white apatite crystals. Lazulite occurs as granular blue patches in interlocking aggregates of muscovite and feldspar adjacent to masses of triphylite. Triphylite occurs in large masses 15 or more feet long in single exposures. The mineral has yielded by its alteration: heterosite, vivianite and incrusting and stalactitic masses of dufrenite. The dufrenite itself alters readily to limonite. Graftonite formerly was abundant on the dump, in masses up to 18 inches in size. The graftonite is interlaminated with triphylite (or heterosite derived from the alteration of the triphylite) and occurs in close association with the large triphylite masses. Zinnwaldite is said by Sterrett to occur in zoned brown and bluish-green crystals. Beryl is abundant in green and yellow-green prismatic crystals about 4 to 6 inches in length. The tourmaline observed at the locality was black and coarsely crystalline. Cyrtolite occurs in small crystals with triphylite. Apatite occurs as thin platy white crystals flattened on {0001} and aggregated into crusts over drusy crystals of colorless quartz. An early formed greenish-blue manganian variety of apatite also occurs.

REFERENCES

BERMAN, H., *Am. Mineral.*, **12**, 170 (1927).
LARSEN, E. S., *U. S. Geol. Surv., Bull.* **679**, 75 (1921).
STERRETT, D. B., *U. S. Geol. Surv., Bull.* **580F**, 72 (1914).

NOTE ADDED IN PRESS

After the above described work was completed, a small and relatively perfect crystal-fragment of whitlockite was prepared and was re-examined by the Weissenberg method. This study verified both the rhombohedral character of the direct lattice and the existence of a glide along [0001]. A superior value of a_0 also was obtained, viz., 10.32Å. This value brings the x-ray and the observed or theoretical crystal constants into very close agreement, as is seen from the following tabulation:

	S.G.	$a:c=1:$	Cell Contents (hex. coords.)				
			Ca	Mg	Fe	P	O
	3.12 (obs.)	3.547 (morph.)	55.6	4.2	3.2	42	168 (theor.)
(new) $a_0=10.32$, $c_0=36.9$	3.15	3.576	54.5	4.1	3.1	41.9	167.4
(old) $a_0=10.25$, $c_0=36.9$	3.19	3.600	53.8	4.0	3.1	41.4	165.1

Attention may be directed to the fact that the space group of whitlockite, $R\bar{3}c$, can not be reconciled with the theoretical cell contents, $Ca_{21}P_{14}O_{56}=7(Ca_3(PO_4)_2)$, since an odd number of cations are present and only equivalent positions occurring in pairs are available.* At least two lines of explanation are available: (1) Chemically different atoms occupy structurally equivalent positions. This interpretation seems improbable in the present instance. (2) Sufficient positions are vacant in the structure to satisfy the symmetry requirements. A possible explanation on this basis may be suggested. In general, in order to have X missing Ca ions in the whitlockite structure, then either $2X$ atoms of a trivalent cation such as Fe^3 must be present in substitution among the remaining cations, or corresponding omissions or substitutions must occur among the anions, in order to compensate the loss in positive valence. The cell contents in the former view may be represented as

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* Remarked to the writer by Dr. Duncan McConnell, Jan., 1941.

$$\left((\text{Ca}, \text{Mg}, \text{Fe}^2)_{63-3X}, \text{Fe}^3_{2X}\right)_{63-X}^{+126} (\text{P}_{42}\text{O}_{168})^{-126}.$$

The following calculation of the cell contents definitely suggests that one of the Ca positions is vacant, giving 62 instead of 63 cations in the cell. However, there is not quite enough Fe^3 present to compensate the loss of valence, although the agreement probably can be regarded as satisfactory in view of experimental error.

Observed number of atoms in cell with $a_0=10.32$, $c_0=36.9$, *as re-calculated to* 168 *oxygen atoms*

$$\begin{array}{l}
\left.\begin{array}{r} =61.9\text{, or } 63-X \\ \text{with } X=1.1 \end{array}\right\{
\begin{array}{l}
\left.\begin{array}{l} \text{Ca} = 54.7 \\ \text{Mg} = 4.1 \\ \text{Fe}^2 = 1.72 \end{array}\right\} \begin{array}{l} =60.5\text{, or } 63-3X \\ \quad \text{with } X=0.83 \end{array} \\
\text{Fe}^3 = 1.38 \quad =2X\text{, with } X=0.69
\end{array} \\
\hphantom{=61.9\text{, or } 63-X\ \ } \text{P} = 42.0 \\
\hphantom{=61.9\text{, or } 63-X\ \ } \text{O} = 168
\end{array}$$

CUTTING OF DIAMONDS FOR INDUSTRIAL PURPOSES

Edward H. Kraus and Chester B. Slawson,
University of Michigan, Ann Arbor, Michigan.

Introduction

In recent years there has been a remarkable increase in the use of diamonds for industrial purposes. According to Ball[1] about two-thirds of the annual diamond production by weight, and one-fourth by value, is used in industry. These industrial diamonds are not of gem quality. They are a by-product of the mining of gem stones.

The use of diamonds in drill bits for exploration and mining operations began about 1864.[2] Diamond drilling is now so widely employed that forty-five per cent of the annual use of industrial stones is for this purpose.

Rapid and precision manufacture of metal parts has been a constant aim in industry in recent years. Diamond-set tools were accordingly developed. These tools are used in various cutting, grinding, and machining processes of metal parts and also for trueing and re-surfacing abrasive wheels. They are employed in many industries and are exceedingly important in the manufacture of automobiles and airplanes. Today diamond-set tools account for about thirty per cent of the annual consumption of industrial stones.

A third important use of industrial diamonds is in the drawing of fine wire and filaments of uniform diameter. For this purpose diamonds are pierced with holes. The wire or filament is drawn through such pierced diamonds, called diamond dies, with successively smaller openings until the desired size is obtained. About ten per cent of the industrial diamonds is used annually for diamond dies.

There are other miscellaneous uses of diamonds in industry which account for fifteen per cent of the yearly industrial consumption.[3]

Only in the cutting and mounting of industrial diamonds in some of the diamond-set tools is any particular attention given to the fact that the hardness of the diamond varies materially with the crystal face and with the direction on the faces.[4] In other instances the orientation of the stone is quite random or it may be based upon the development of the diamond, preference being given to stones with a tabular habit regardless of what the largest faces may be.

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[1] Ball, Sydney H., The diamond industry in 1939: *The Jewelers' Circular-Keystone*, August, **1940,** p. 15.

[2] Grodzinski, P., *Diamant-Werkzeuge*, Berlin, **1936,** p. 154.

[3] Reference 1, p. 16.

[4] Kraus, E. H., and Slawson, C. B., Variation of hardness in the diamond: *Am. Mineral.*, **24,** 661–676 (1939).

It is the purpose of this paper to describe in general terms the preparation of industrial diamonds for diamond-set tools and diamond dies; and to correlate the practice of the industry with our present knowledge of the variation of hardness in the diamond and its crystal structure.

Diamond-Set Tools

Experience has shown that in shaping a diamond for use as the cutting edge of a machine tool, the edge must be so disposed that it will offer the greatest resistance to breakage. Because of the superior hardness of the diamond, abrasive wear is not the important factor in the life of the tool. It is the excellent cleavage of the diamond that most often causes the tool to fail. The cutting edge, hence, should be formed so as to offer the maximum resistance to cleavage and be shaped so as to eliminate possible chipping. Because a sharp point is more readily chipped, it is preferable to give the tool more body and accordingly the cutting edge is commonly a curved "nose."

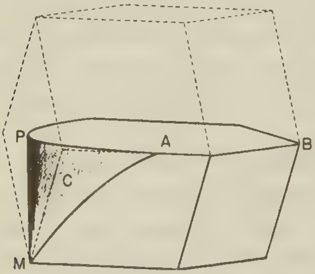

Fig 1

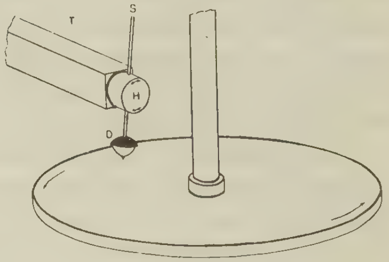

Fig. 2

Figure 1 shows one of the many types of diamond-set tools which possess curved noses. This figure is well adapted to illustrate the various processes that are used in shaping the tool. The top of the tool *A*, is called the "face," and is parallel to one of the planes of the dodecahedron. The part of the tool *C* is called the "flange." The direction *PB* on the face is parallel to the long diagonal of the dodecahedron plane. The direction *PM* on the flange is also parallel to the long diagonal of a second dodecahedron plane. These two planes or crystal faces intersect at 90°. The flange is approximately cylindrical and its axis is parallel to *PM*. The cutting point is at *P*.

In shaping the stone the face *A* (Fig. 1), is cut first. The stone is then placed in a small solder dop *D* (Fig. 2), so that *PB* (Fig. 1), is parallel to the axis of the dop; that is, a dodecahedron face is exposed for cutting the flange. The stem of the dop *S* (Fig. 2), is now placed in the holder *H*, which extends from the end of the "tong" T, and permits the dop to rotate about the axis of the tong. The dop must be so oriented that the direction PM (Fig. 1) is parallel to the axis of the tong. The stone, oriented in this manner in the dop, is placed upon the skeif, so that a portion of the crystal which corresponds to an octahedron face is subjected to cutting. To form the required cylindrical surface the dop must be rocked forward about the axis of the tong. This movement on the skeif must be in one direction only, that is, from an octahedron to a rhombic dodecahedron face, for cutting will take place only in this direction. The tong is then raised from the skeif and the dop rocked back to the original position and the movement repeated. This rocker motion, forward and backward, is repeated rapidly until the surface is finished.

Only one-half of the flange can be cut in this way. This is due to the fact that the hardness of the diamond decreases in passing from an octahedron to a dodecahedron plane and that when the plane of the dodecahedron is reached the sense of the cutting direction is reversed.[5] Hence, it is necessary that the rocker movement start slowly and increase in speed. The cutting ceases abruptly because of the change in the sense of direction when PM (Fig. 1) is reached.

Since only one-half of the flange can be cut in this way, the position of the stone with respect to the skeif must now be reversed in order to cut the other half. This is done by rotating the dop 180° about its axis. The two halves of the curved flange are then lapped into one. Because of the variation in hardness, and hence in the rate of cutting, and also because the two curved surfaces must be carefully lapped into the finished flange, the skill of the workman is the major factor in the efficiency of the operation.

Since the angle between the normals to adjacent faces of the octahedron and the dodecahedron is approximately 35°, a nose with a circular arc up to 70° can be cut by the two operations described. If an arc of more than 70° is desired, additional operations with different cutting directions are required.

As is well known, the cutting of gem diamonds was developed by empirical methods based upon long years of experience. Thus gem cutters discovered very early that the direction of the long diagonal of the dodecahedron face is a hard direction, and accordingly this direction has been called a "rib." The intersection of such ribs is designated as a "hard corner." In the cutting of diamond-set tools the experience and practice of the gem cutting industry have been drawn upon, and, as is evident, the cutting point P (Fig. 1), is a "hard corner."

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[5] Reference 4, p. 663 ff.

The life of a tool, as already indicated, depends upon the orientation and the design of the stone. The type illustrated in Fig. 1 has been proven to have the longest life. This is because the cutter has taken advantage of the most favorable inherent properties of the diamond and the manner in which the tool is to be used. The curved surface which is produced by two operations and lapping gives the tool the greatest strength. In the use of the tool the cutting force is applied in a direction parallel to the long diagonal of a dodecahedral plane, which is a rib or resistive direction. In cutting the stone the direction at right angles to a rib, namely, parallel to the short diagonal of a dodecahedral plane, is used because it is a softer direction.

In Fig. 1 the "lip angle," that is the angle between the directions *PB* and *PM* is 90°. In practice it may be necessary to reduce this angle somewhat in order to provide the tool with "end clearance." This is done by giving the face of the tool *A*, the proper inclination to the flange *C*. The nose remains the same and the direction of the cutting force is still parallel to the long diagonal of the dodecahedral plane.

In addition to the tools of the type described, many machining and grinding operations require diamond tools of special design. For example, "chisel-pointed" stones are used to cut the v-shaped depressions of gears. "Pointed" stones are also necessary to cut depressions into the faces of abrasive wheels used to grind gear teeth. All stones for diamond-set tools are shaped entirely by hand, and are carefully checked by projecting an enlarged image of the finished tool upon a large scale drawing which has been made according to the required specifications.

Specially-shaped industrial diamonds are being used increasingly. Their development is greatly retarded, however, because the tool designer does not usually possess an adequate knowledge of the inherent physical properties of the diamond. Thus abrasive hardness is commonly confused with brittle hardness or toughness. Moreover, it is not realized that the diamond cannot be machined like a metal but that the cutting operations on the diamond are dependent upon the selection of favorable directions. This generally causes the tool designer to expect too much of the diamond itself as well as too much from the average diamond cutter.

Diamond Dies

In the preparation of diamond dies it is common practice to select stones with a tabular habit so as to reduce grinding and polishing to a minimum. Such stones are usually distorted rhombic dodecahedrons or octahedrons. The stones are first mounted in metal and then pierced with a small hole of the required dimension in a direction perpendicular to the tabular surface. Generally a slight conical depression is first made with a drill having a sharp diamond point. The actual drilling then takes place. This is essentially a grinding and pecking process. For this purpose a sharp steel point revolves in the conical depression. Fine diamond dust in oil is regularly applied to the revolving point or needle. Depending upon the size of the hole to be drilled the needle revolves from 1500 to 2500 times a minute. The drilling apparatus is so designed that as the needle revolves the mounted stone vibrates gently against the needle point two or three hundred times a minute; that is, as the needle revolves it also pecks. By this pecking process minute cleavage fragments are broken loose which augment the diamond dust in the oil and hence materially hasten the drilling process. It must be pointed out that the actual grinding or drilling is not done by the steel point but by the diamond dust between the needle and the stone.

After the diamond has been pierced in this way, the opening must be accurately shaped and sized and also highly polished. This is accomplished by moving a wire or a revolving needle to and fro in the hole of the diamond, which is constantly rotated. This process is a delicate one and requires carefully adjusted apparatus.

The boring and polishing processes are very slow and may require several days or even weeks of continuous operation. In the preparation of a diamond die as much as twenty to twenty-five per cent of the original weight of the stone may be lost.[6]

As has been indicated, tabular crystals are generally selected for diamond dies for natural and economic reasons. The dominant faces on such crystals are either those of the octahedron or the dodecahedron. If cubical crystals, which are common, were used, or if surfaces on octahedral or dodecahedral crystals were ground parallel to a face of the cube, the boring of the hole and the polishing of the surfaces of the die should be accomplished more readily than when distorted octahedral or dodecahedral crystals are used. This is because the cube face is softer than either of the other faces and also because the direction of the hole would be parallel to a crystallographic axis. According to theory the hardness of the stone in this direction is less than in the others. Moreover, the hardness of the diamond is greatest on faces of the octahedron. On faces of the dodecahedron it is intermediate between those of the cube and of the octahedron.

In the present practice of drilling diamonds for use as wire-drawing dies the ultimate effect of the excellent cleavage does not seem to have been adequately taken into account. The effect of the cleavage will be

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[6] Reference 2, p. 181.

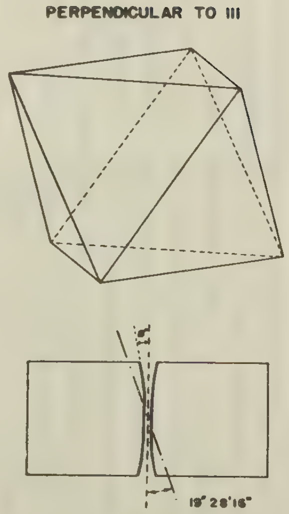


Fig. 3

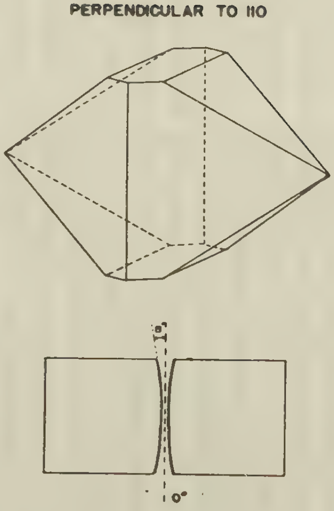


Fig. 4

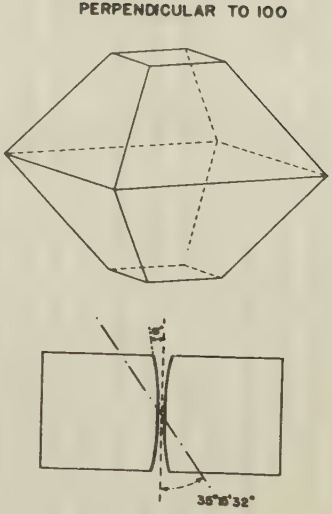


Fig. 5

discussed for three directions of drilling, namely, perpendicular to a plane of

1. the octahedron,
2. the rhombic dodecahedron, and
3. the cube.

1. When drilled perpendicular to an octahedron plane (Fig. 3), three cleavage directions are inclined at about 19° to the axis of the hole, while the fourth is perpendicular to the hole. If, as is frequently the case, the conical wall of the entrance opening makes an angle of about 8° with the axis, it follows that the direction of the drawing force of the wire impinges upon the wall of the opening which makes at three points an angle of 11° with each of the three cleavages. If the angle of the entrance opening is increased, this approximate parallelism becomes greater and at 19° the parallelism is complete.

2. When the diamond is drilled perpendicular to a rhombic dodecahedral plane (Fig. 4), there are two cleavages exactly parallel to the axis of the hole and two which are inclined at angles of 55°. It is well known that cleavage takes place most readily when a force is applied parallel to a cleavage plane, especially if the cleavage is a perfect one as is the case in the diamond.

3. When the hole is drilled perpendicular to a plane of the cube (Fig. 5), the four possible cleavage planes are all equally inclined to the axis, at approximately 35°.

Since cleavage breaks are frequently the cause of the failure of dies, it would appear that the axis of the hole should not, for obvious reasons, be parallel or approximately parallel to cleavage planes, but rather should be inclined to them at as large an angle as possible. From the above discussion it is evident that cleavage failures are more likely to occur when the holes are drilled perpendicular to planes of the dodecahedron or of the octahedron than when perpendicular to the cube.

In order that a wire-drawing die may render the maximum efficiency the constancy of the drawing hole should be maintained for the longest possible period, that is, the hole should remain circular and of fixed diameter. This is very essential since dies are used in a continuous series, that is, in a train, and the wire is drawn through them at speeds of 3000 to 12,000 feet per minute, depending upon the diameter and composition of the wire.

Experience shows that with use the circular holes of the dies tend to change in form. They frequently become elliptical. These changes in form may, it is thought, be correlated with the variation of hardness with direction, and with the crystal structure of the diamond. Investigation of these changes should prove fruitful.

ACKNOWLEDGMENTS

We are greatly indebted to Mr. Harvey B. Wallace, President of the Wheel Trueing Tool Company, Inc., of Detroit, Michigan, for the many courtesies extended to us, and to Mr. J. Levy of that organization for his interest in our studies and especially for permission to describe the method of grinding and polishing curved surfaces on the diamond as developed by him.

PRESENTATION OF THE THIRD ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA TO LEONARD JAMES SPENCER

A. N. WINCHELL, *University of Wisconsin, Madison, Wisconsin.*

About ten years ago the Council of the Mineralogical Society of America made plans to establish a medal in recognition of exceptionally distinguished work in the field of mineralogy. The first award of the Roebling Medal was made in December, 1937, to Professor Charles Palache, the recognized leader in the field of mineralogy in America. The second award was made the following year to Dr. Waldemar T. Schaller of the United States Geological Survey in appropriate recognition of his distinguished services to the Society and to the science of mineralogy.

This year the committee has wisely selected as the recipient of the honor a man who is not an American, thus emphasizing the fact that the medalist is chosen as a leader in mineralogy, not merely in America, but in all the world.

Leonard James Spencer was born in Worcester, England, in 1870. He obtained his education in science in a series of institutions, beginning in the Technical College at Bradford in Yorkshire, continuing at the Royal College of Science at Dublin, Ireland, the University of Cambridge, England, and the University of Munich, Germany. He won honors at Dublin and the Harkness University Scholarship at Cambridge.

He expected to become a geologist, but his first opportunity in science came in 1894 as an assistant in the Mineral Department of the British Museum, and that circumstance diverted his attention to mineralogy, although he had begun collecting ammonites and belemnites on the Yorkshire coast at the tender age of seven years!

He became a member of the Mineralogical Society of London in 1894, a member of the Council in November, 1899, and succeeded Professor A. H. Miers as Editor of the *Mineralogical Magazine* at the end of 1900. He is, therefore, just now completing forty years of service in that capacity and during that time he has edited thirteen volumes of the Journal. In January, 1920, he established *Mineralogical Abstracts*, of which seven volumes have now been published. It is a mere statement of fact to say that *Mineralogical Abstracts* has come to be recognized very generally as the best publication of its kind. It is now the chief source of prompt information regarding all publications in the field of mineralogy, and, as such, it is of fundamental importance in all research work in our science.

For forty-three years he has been publishing a list of new mineral names in each volume of the *Mineralogical Magazine* and the fifteenth list of this series has just made its appearance.

Dr. Spencer has written many scientific articles dealing with the characters of minerals; for example, he proved that binnite is only a synonym of tennantite, and he described accurately and gave names to eight new minerals. He has made elaborate and important studies of meteorites and tektites. A hydrous zinc phosphate from British Columbia has been named spencerite in his honor.

He made a skillful translation of two large volumes—one, R. Brauns' "Das Mineralreich," and the other, Max Bauer's "Edelsteinkunde." He has published two books of his own; the first one is "The World's Minerals," published in 1911, and the second is "A Key to Precious Stones," which appeared in 1936.

It is remarkable how widely his ability as an abstractor has been used. He has prepared abstracts in the field of mineralogical chemistry ever since 1895 for the Chemical Society of London. He was referee for the mineralogy volumes of the International Catalogue of Scientific Literature from 1900 to 1914. He was collaborateur for crystallography and mineralogy for the international "Tables annuelles de constantes et données numeriques" from 1911 to 1930. He prepared many articles on minerals for the eleventh to fourteenth editions of the Encyclopedia Britannica, and articles on economic minerals for Thorpe's Dictionary of Applied Chemistry.

He has received many honors, including an honorary degree from the National University of Ireland; the Geological Society of London awarded him the Wollaston Fund in 1902 and the Murchison Fund in 1937. He is an honorary life fellow of the German Mineralogical Society, and of the Royal Geological Society of Cornwall, which presented to him its Bolitho gold medal. He has been a corresponding member of the Mineralogical Society of America since the first small group of such honorary members was selected in 1927. He was President of the Mineralogical Society of London from 1936 to 1939.

He became a Fellow of the Royal Society in 1925, and Commander in the Order of the British Empire in 1934. He is also a Fellow of the Geological Society of London, of the Chemical Society of London, and of the Royal Geographical Society.

It is a great pleasure to me that I am given the honor to announce the award of the Roebling medal of the Mineralogical Society of America to Dr. Leonard James Spencer and to present it to Mr. Harold E. Slaymaker, British Consul in Houston, Texas, for transmittal to the one we are glad to honor.

ACCEPTANCE OF THE THIRD ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA

BY LEONARD JAMES SPENCER

The welcome news (first received through the British Foreign Office—a reliable source of information) that I had been selected for the award of the third Roebling Medal came to me as a great and very pleasant surprise on my seventieth birthday. This is indeed an honour that I deeply appreciate and I sincerely thank the Mineralogical Society of America for so signal an award. It is, I believe, the only medal in the whole world that can be awarded to a mineralogist. Although geological societies have a profusion of medals to bestow (personally I have two such medals), yours is the only mineralogical society that has instituted a medal. To be the third recipient, following the distinguished American mineralogists Professor Charles Palache and Dr. Waldemar T. Schaller, is a special gratification to one in a foreign country. Apart, however, from any personal satisfaction, it is a true indication of the international cooperation and good will that must and will prevail in all scientific work. That the first award outside the United States should come to Great Britain is a symbol of the close bond between our two English-speaking countries, and this will I am sure be much appreciated by British mineralogists.

My record, as I see it myself, scarcely seems to justify this award. I can only say that I have stuck at my job for a number of years; but having now been so rewarded I begin to feel that my efforts have not been altogether unsuccessful. The only way to become a mineralogist is to start when quite young collecting minerals for oneself in the field. At the age of seven my father gave me a geological hammer, partly perhaps with the idea that if superfluous energy was diverted to the breaking of rocks, other forms of destruction would be avoided. While still a schoolboy, I had formed a collection of some thousand specimens of fossils, minerals, and rocks, mostly from Yorkshire localities, all methodically numbered, labelled, and catalogued. My first serious study of the subject was under a charming old Irish professor, J. P. O'Reilly, at the Royal College of Science in Dublin. Three years there gave further scope for collecting. Then four years at Cambridge University where geology and mineralogy were my principal subjects. Just at the end of the Cambridge course there fortunately happened to be one of the infrequent vacancies in the scientific staff of the Mineral Department of the British Museum, and then was my chance to become a real mineralogist. After appointment in 1893, I was allowed leave for a few months for further study in crystallography under Professor Paul Groth at the University of Munich.

Leonard James Spencer, Recipient of the Roebling Medal of the Mineralogical Society of America

The British Museum offers wonderful and unique opportunities and a serious student who is willing to work overtime at home can scarcely help but make good. The Museum was established in 1753 and it absorbed several old collections. To the accumulation of collections there is apparently no end, and in 1881 the Natural History Collections were crowded out from the main British Museum building at Bloomsbury and removed to a new building, the British Museum of Natural History at South Kensington. Since then there has been a steady growth year by year in the collections. Curatorial work and the preservation of records are the first duties, but there are ample opportunities for research work on the accumulations of material. I have myself made some original contributions to mineralogical literature, and there may be one or two papers that I now regret having published. But I have always avoided hasty publication, and in some cases have waited twenty years or more before publishing uncertain and incomplete results.

Since my retirement from the Museum in 1935 under the Civil Service age limit, I have fortunately been able to continue my work, mainly in connexion with the *Mineralogical Magazine* and *Mineralogical Abstracts.* As editor of the *Magazine* since 1900, I have had no hesitation in inviting authors to reconsider their papers and if necessary to rewrite and curtail them. In this I have, with very few exceptions, found authors most reasonable and grateful for assistance. Points most obvious to the author himself (sometimes even his own name in the title) are often omitted, to the confusion of the chance reader. *Mineralogical Abstracts* were started systematically in 1920 as a sequel to the International Catalogue of Scientific Literature which terminated in 1914. Attempts have been made to select for abstracting only those papers of real value and importance, rather than blindly including all and every paper; and the indexing has been taken seriously. With regard to my own work, I regret to say that lately I have rather forsaken pure mineralogy for meteorites and natural glasses; but I keep a sharp lookout in the literature for new minerals.

Comparisons are often odious, but I think that some comparison of the British Mineralogical Society and the Mineralogical Society of America may be useful and to the advantage of the latter. Your society is to be congratulated this year on its coming of age, having been founded in December 1919. It is a very virile and live society—and it has instituted a medal. Your membership and subscription list (numbering 1042 in 1939) is just about double that of the much older British Society (founded in February 1876), and each year you publish a fat volume full of valuable data, as against one volume in three years of the *Mineralogical Magazine.* By a strange coincidence this December sees the completion of the twenty-fifth volume of both the *American Mineralogist* and the *Mineralogical Magazine.* I am the proud possessor of complete bound sets of both of these periodicals. The *American Mineralogist* in twenty-four and one-half years has filled up shelf space of very nearly one metre (99 cm.), while the *Mineralogical Magazine* in sixty-five years runs to only 90 cm. In addition, however, there are now seven volumes of *Mineralogical Abstracts* running to 29 cm.

As a recipient of the Roebling Medal, which was founded in memory of Colonel Washington Augustus Roebling (1837–1926), I recall with pleasure my visit in August 1924 to him and Mrs. Roebling at their home in Trenton, New Jersey. He was a most affable and generous old gentleman, then aged 87, and I was much impressed by his fine and well-ordered collection of minerals. In addition to many fine show specimens, he had made a special effort to have represented in his collection every known variety of mineral—even mere names. It was remarkable how he knew and remembered every specimen; as a test I was invited to call for something quite obscure, which to his great joy and pride was immediately produced. Following my visit I had several interesting letters from him up to the time of his death. He was an excellent correspondent and wrote in a very small neat hand; he had no use for writing machines—nor for automobiles.

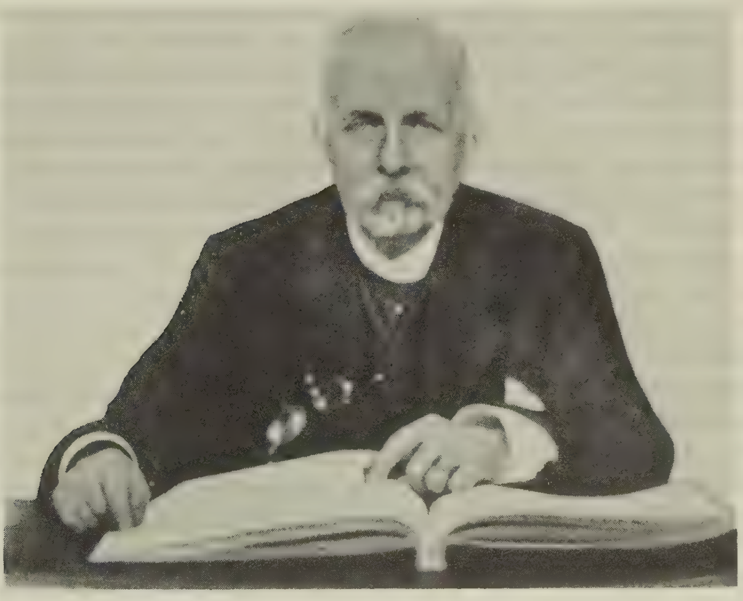
Again I express to the Mineralogical Society of America my sincere thanks for the generous award of the highest recognition that it is able to bestow. I feel highly honoured. My only regret is that under present circumstances it will be quite impossible for me to attend the meeting of the society and receive the medal in person. I should have much liked to have repeated my previous pleasant and profitable visit to the United States. I am grateful to the British Foreign Office for instructing His Majesty's Consul (to whom also my thanks are due) at Houston, Texas, to receive the medal on my behalf.

MEMORIAL OF WALDEMAR CHRISTOPHER BRÖGGER

OLAF ANDERSEN,
Stevens Institute of Technology, Hoboken, New Jersey.

With the death of Dr. W. C. Brögger, Professor Emeritus of the University of Oslo, on February 17th, 1940, the science of geology lost one of its most outstanding workers, and Norway lost an ardent patriot and faithful public servant, a truly great son.

Waldemar Christopher Brögger was born in Oslo on November 10th 1851, his parents being Anton Wilhelm and Oline Maria (Bjerring) Brögger. He received his preparatory education in Oslo where he graduated from the "Gymnasium" and was matriculated at the university in 1869. He devoted his entire time at the university to an independent study of science on a broad basis and laid the foundation for the remarkable mastery of the several branches of geology, including mineralogy, that was such a striking feature of his scientific work.



WALDEMAR CHRISTOPHER BRÖGGER
1851–1940

Brögger's professional career may be characterized as easy from the start, his great gifts, thorough knowledge and inspiring personality opening the way for him to the positions he desired for his life's work. He became an assistant at the Norwegian Geological Survey in 1875 and retained his connection with the survey as a collaborator for the greater part of his life. From 1876 to 1881 he was associated with the University of Oslo as a curator and research fellow. In 1881 he was called to the University of Stockholm as professor of mineralogy and geology and thus attained the position of a full rank professor at the early age of thirty. He was called back to Norway as professor of mineralogy and geology in the University of Oslo, in 1890, and remained active in this professorship till his retirement in 1916.

Through his activity as a university teacher in Stockholm and Oslo, Brögger exerted a great influence on the development of geology in the countries of northern Europe. In Stockholm pupils from all these countries flocked to his classes and among them were many who later became prominent in various fields of geology. In Oslo he became the teacher of practically all Norwegian geologists, mining engineers and natural history instructors now of late middle age or older. During the last ten years or so of his service as professor, heavy public duties forced him to leave most of the teaching to others. In the course of his 24 years of retirement he devoted a major portion of his time to research work in geology.

Brögger's scientific activity extended over nearly all branches of geology; indeed it included zoology and archaeology; but his most important work was in the fields of mineralogy and petrography. As the years passed by, his work was more and more concentrated on petrography and he became one of the leading petrographers of his time.

After publishing a paper on the molluscs of the Oslo fjord in 1872, Brögger concentrated entirely on geology and published his first geological paper, on giant pot holes, jointly with Reusch, in 1874, and his first mineralogical paper, on large crystals of enstatite, in 1876. Thereafter for many years he devoted a considerable part of his time to mineralogical studies, his main interest being the minerals of the syenite pegmatites of the Oslo region. A number of papers containing descriptions of new minerals and new data on previously known minerals from these pegmatites were published and the complete results were gathered in the unique monograph: "Die Mineralien der Syenitpegmatitgänge der Südnorwegischen Augit- und Nephelinsyenite," appearing in 1890 as volume 16 of *Zeitschrift für Krystallographie und Mineralogie.* This remarkable volume of two separately paged parts contains in the first part of 235 pages, an outline of the general geology of the Oslo region and the special geology of the syenite pegmatites, and in the second part of 663 pages, detailed descriptions of the 70 odd minerals occurring in the pegmatites.

An opinion on the scientific value of this monograph was expressed at the time of its publication in the following words of Professor P. Groth: "The present publication will, no doubt, become of epoch-making importance for the knowledge of the natural history of Scandinavia." Another important contribution to mineralogy was Brögger's work on the minerals of the granite pegmatites of southern Norway, but this work was only partly finished. Its results were published in a number of separate papers and in the monograph: "Die Mineralien der Südnorwegischen Granitpegmatitgänge. I. Niobate, Tantalate, Titanate und Titanoniobate" (the *Academy of Sciences of Oslo*, 1906). This monograph would have contributed everlasting value if it added nothing more to mineralogy than all its chemical data. It contains sixteen new analyses of these extremely complicated rare earth minerals, and gives detailed discussions of their chemical and crystallographic relationships. Also the listing of numerous localities and a summary of the geology of the granite pegmatites are features of considerable importance in this publication. Brögger's only later publication in the field of mineralogy was a brief paper giving supplementary crystallographic data on hellandite, published in 1922. As a conclusion of the remarks on Brögger's work in mineralogy it may be stated that the following minerals were named and first described by him: nordenskiöldine, hambergite, johnstrupite, calciothorite, låvenite, hiortdahlite, rosenbuschite, barkevikite, cappelenite, melanocerite, mossite, blomstrandine, priorite, and hellandite; and that the mineral bröggerite, a helium-bearing octahedral variety of uraninite, was named after him.

Brögger's work in petrography was largely concerned with the igneous rocks of the Oslo region, but he also made important contributions to the study of pre-Cambrian rocks. The results of his work on the igneous rocks of the Oslo region were published from time to time between 1890 and 1933, and are contained in a number of papers and particularly in the following monographs having the main title: "Eruptivgesteine des Kristianiagebietes" (Oslogebietes) and the following sub-titles: "I. Die Gesteine der Grorudittinguait serie (1894), II. Die Eruptionsfolge der triadischen Eruptivgesteine bei Predazzo in Südtyrol (1895), III. Das Gangefolge des Laurdalits (1898), IV. Das Fengebiet in Telemark, Norwegen (1921), V. Der grosse Hurumvulkan (1930), VI. Über verschiedene Ganggesteine des Oslogebietes (1932), VII. Die chemische Zusammensetzung der Eruptivgesteine des Oslogebietes (1933)." All these were written in German and occur in the regular series of publications issued by the *Academy of Sciences of Oslo*. The following two were written in Norwegian and published in 1933 in the series of the Norwegian Geological Survey: No. 138—The eruptions of the essexite series. The oldest volcanic activity in the Oslo region; and No. 139—On the rhombporphyry dikes and their accompanying faults in the Oslo region.

Rocks from the pre-Cambrian areas adjoining the Oslo region were described by Brögger in the last two publications written by him: "On several Archäan rocks from the south coast of Norway, I—Nodular granites from the environs of Kragerö" (1934), and "II—The South-Norwegian hyperites and their metamorphism" (1935), published by the Academy of Sciences of Oslo. These two volumes on which he worked intermittently for many years, were written in English by Brögger, as a compliment to American friends, although he labored arduously with the language, having learned it late in life. "I am using the dictionary and the grammar all the time," he once told me. In the preface of the first volume he sends " . . . a cordial and grateful greeting to noble friends among American petrographers and geologists, a greeting full of remembrances from unforgotten and ever memorable days during a visit to the United States 32 years ago . . . " In volume II, on hyperites, Brögger gives very thorough descriptions of all the structural details of these and other rocks and publishes a number of new analyses. The detailed discussion of corona structures is of particular interest.

Brögger's great monograph on the late glacial and post glacial changes of level in the Oslo region with descriptions of the faunas of the Quaternary clay deposits, and his treatise on the levels of the strand-line during the stone age in south-eastern Norway, should also be mentioned as among his important publications. They were written in Norwegian and published in the series of the Norwegian Geological Survey as Nos. 38 (1900) and 41 (1905), respectively.

In the Trondheim district and the Hardanger "Vidda" (plateau) Brögger pursued studies involving stratigraphic and structural problems. At the latter place he worked as a member of a government commission investigating the problems of the mountain passage of the Oslo–Bergen railroad. His work on this commission is said to have played no small part in the successful completion of this difficult engineering project which was finished in 1910, after many years of construction.

Brögger's work on the geology of the Oslo region mentioned above, deserves a few additional remarks. This region extends in a general north-south direction between the Oslofjord and Lake Mjösa. It is about 140 miles long and 22–35 miles wide and covers an area of about 4000 square miles. The region is characterized by the occurrence of a great variety of intrusive and extrusive igneous rocks of the alkaline type associated with older paleozoic sedimentary rocks, the whole complex being surrounded by pre-Cambrian rocks and being preserved from denudation by subsidence along fissure faults. The main features of the geology of the region were known from earlier investigations, indeed, the "Christianiagebiet" was famous among geologists of the nineteenth century, but a large amount of detailed observations and thorough revisions of the old interpretations were highly desirable. This immense task Brögger undertook at the outset of his career as a geologist and continued it for over sixty years. Aided by a number of younger assistants, he and his collaborator, the late professor J. Schetelig, mapped the region in great detail and published ten sheets on a medium scale (1:100,000) of the greater part of it, and an outline map on a scale 1:250,000 of the entire region. He brought together enormous collections of minerals, rocks and fossils from all parts of the region and examined this material by all available laboratory methods. The results of this work were published in over sixty papers (including the monographs mentioned above) covering subjects in mineralogy, petrography, paleontology, stratigraphy, structural geology, and Quaternary geology. Impressive as this work is, it does not cover nearly all the items of the Oslo region or what Brögger had planned to do. It is particularly to be regretted that the complete summary of all petrographic-geologic data, and the petrogenetic conclusions based on them, alluded to by Brögger in one of his monographs, was never published. It is fortunate, however, that in his last publication on the Oslo region (No. VII in the series mentioned above) he gave a complete, classified list of all the 331 analyses made on the igneous rocks of the region with brief remarks on the igneous history of the rocks. In other monographs (particularly Nos. I and III of the series) he dealt at length with problems of magmatic differentiation, the clarification of which is to a considerable extent due to Brögger's studies in the Oslo region. He established as an empirical rule, the analogy between sequences of crystallization, differentiation, and eruption—the rule of increasing acidity—which also has been found to hold true, in a general way, for a number of other comagmatic regions.

Besides the publications containing the results of his personal research work, Brögger wrote an excellent outline of the geology of Norway and numerous popular articles on a variety of subjects, usually contributed to newspapers.

During the last fifty years of his life, while active and as a retired professor in Oslo, Brögger became engaged in numerous activities in addition to his university work. Thus he served as a member of the Storting (Parliament) for the term 1906–1909 and used much of his influence as a legislator to improve the economic conditions of scientific and educational institutions in Norway, nearly all of which are owned and operated by the state. After having been instrumental in reorganizing the administrative system of the University of Oslo, he was elected its first rector in 1906 and re-elected for several years, serving in 1911 when he had the strenuous task of organizing and leading the centennial celebration of the university. He did a magnificent work for the general welfare of the university, obtaining among other things, appropriations for highly needed new buildings. For many years he was president of the Academy of Sciences of Oslo and contributed greatly to the advencement of this organization. He was one of the three honorary members of the venerable patriotic organization, "The Society for the Welfare of Norway," and held positions of trust and honor in several other organizations. As early as 1896 he began his illustrious activity as "the biggest beggar in Norway" (self styled), collecting funds from private sources for scientific work and he kept it up for many years thereafter. This was no easy task in a country where large fortunes are few and far between and where tradition, when Brögger began his "begging," did not favor donations to science as much as to religious organizations and charity. However, Brögger's tremendous energy and great power of persuasion overcame all difficulties, and the results of his personal efforts and of his leadership and inspiration were funds amounting to several million dollars, the proceeds of which have been at the disposal of Norwegian scientists for their projects of research and the printing of their reports. Brögger was also largely responsible for shaping the extremely liberal rules under which grants from the funds were distributed, and for many years he took a leading part in the administration of the funds.

Brögger's cultural interests were many-sided; he appreciated literature and art and was always on the alert against attempts of restricting the perfect liberty of expression in any fields of intellectual activity. His musical talents were so prominent that in his early youth he hesitated for a while before he chose the career of a scientist instead of that of a musician. In politics Brögger was a conservative liberal, always lined up with those who represented progress and democratic ideals. He had traveled widely visiting most European countries and also the United States where he spent some time in 1902, making a round trip traveling as far as the west coast and becoming a friend for life of most American geologists of prominence then living. He often spoke about these friends in words of love and admiration.

Brögger's work as a scientist and public servant was widely recognized not only in Norway, but in many foreign countries whose sovereigns and institutions honored him in various ways. He received several prizes and medals, among them the highly cherished Wollaston medal of the Geological Society of London (1911), and held honorary degrees from a number of universities. The Grand Cross (the highest degree) of the Order of St. Olav was awarded to him by the King of Norway in 1911, and he also held orders of knighthood from Denmark, Sweden, Germany, France, Italy, and Russia. He was a Foreign Member of the Royal Society and an Associé de l'Institut de France, and was elected to membership in about thirty other learned societies.

With all his accomplishments and honors Brögger remained to his death a delightfully human person. He did not suffer from false modesty, for he honestly knew his own worth, but he was easily approached and those who made his acquaintance would find him an interesting and charming man, at the same time they would be impressed by the vigor of his personality. His dynamic energy was an inspiration to most of those who came in contact with him, although some might be taken aback by the strides of the giant. As one of his colleagues said when he compared Brögger, the organizer, with a rotary snow plow forcing its way through densely packed drifts: "It is a magnificent sight, but those who happen to come close to the plow may not always be comfortable." Brögger was fearlessly honest and outspoken and never afraid of a fight if the occasion called for it; but he was far from meddlesome and never posed as a sage; indeed, the restraint of this man of unusual insight and knowledge was quite remarkable. His helpfulness towards those he considered worthy of help was unstinted. expressed as it was in efficient action, not merely in considerate words.

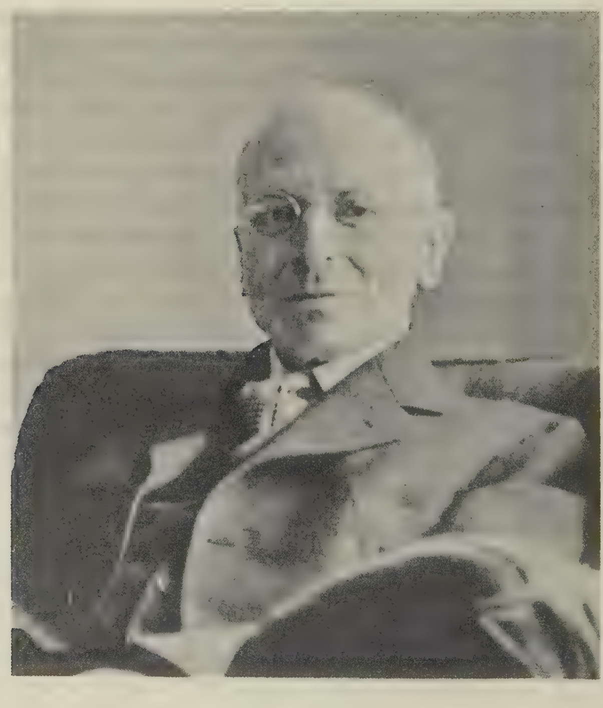
In spite of much illness during his long life, Brögger was physically fit almost to his death, but his memory became slightly deficient during the last five or six years of his life. He died from kidney trouble after an illness of two weeks. His funeral services were held in the large festival hall of the University of Oslo, which was filled to capacity by a gathering representing a good cross-section of the people of Norway. The King, the Crown Prince, the Prime Minister, and numerous other representatives of government, politics, science, art, industry, and business were present together with Brögger's family, friends and colleagues, and hundreds of students from all departments of the university. Memorial meetings were held for him by the Norwegian Geological Society and the Academy of Sciences of Oslo. On all these occasions as well as in the obituaries of the newspapers, tribute was paid to Brögger as a great scientist, an inspiring organizer, and a warm hearted patriot. It was said that Norway is not likely to have another son his equal for a long time.

MEMORIAL OF LAZARD CAHN

Charles Palache, *Harvard University, Cambridge, Mass.*

Lazard Cahn was born in St. Joseph, Missouri, May 23, 1865. His parents were both of French nativity and came to the United States from Rheims.

By the time Lazard was ready for school, the family had moved to New York City, where he spent his earlier school days. When he was fifteen he was sent to Stuttgart, Württemberg, for two years. He continued there the usual studies and also studied the piano on which he became a very good performer. On returning to the United States he entered Stevens Institute. His great interest at this time was chemistry and he planned to enter Yale University for advanced study of the subject, but the illness of a sister caused him to give up this plan and he went west to be with her.



Lazard Cahn
1865–1940

In Colorado Springs he learned of some rare minerals, the hydrous fluorides and others, which had been found at St. Peter's Dome nearby. His interest in these minerals was aroused on account of their unusual chemical constitution, but as his knowledge of minerals grew his enthusiasm for mineralogy increased and he was soon studying intently the subject in which he was to become so expert.

Mr. Cahn later studied mineralogy more formally in American universities and studied crystallography under Dr. Victor Goldschmidt at Heidelberg, but his excellence in morphology was due to his life-long absorption in it.

For a number of years, beginning about 1896, he dealt in minerals, traveling in this country, Mexico and in Europe, making many acquaintances and friendships which endured to the end. I think that one may say that those with whom he dealt came to feel complete confidence in his integrity and in his knowledge.

The writer's acquaintance with Lazard Cahn began about 1900 when he made periodical trips to Cambridge with specimens for sale. We soon found a basis for congenial friendship in our mutual love of crystallography. He was really only interested in crystallized minerals, and it was wonderful how much he succeeded in seeing on the most minute crystals with only the binocular microscope to aid him. During the winter of 1914–1915, not long after his stay in Dr. Goldschmidt's laboratory, he spent some time measuring crystals with me and increased his knowledge of crystal drawing. His drawings were exquisite; he sometimes reduced them by photography and printed the crystal figure on the label of the specimen illustrated. He also developed a method of cutting out of cardboard the various angles obtained by contact measurements of larger crystals. I have such a card carrying on its edges every angle of a very complex rhodonite crystal from Franklin, which he sold to our collection. The values of the angles and the indices of the faces between which they lie are written on the card with his delicate pen.

It was the author's good fortune to be able to give Cahn's name to a mineral which proved to be most unusual both in composition and crystal form. He first detected the minute colorless crystals with his binocular and sketched their peculiar form with accuracy. The name was attached to the species with Mr. Cahn's consent before enough of it was at hand for any chemical tests. We had to wait thirteen years for the mineral to turn up again at Franklin, but when it did it more than justified my faith that it was a new species. It proved to be a boro-arsenate of calcium—a type of chemical compound hitherto unknown among minerals. The full description was published in 1927. Another decade passed and again Mr. Cahn discovered a new fact about this mineral. On one of his micromounts are crystal faces which prove cahnite to have a type of symmetry not before found on any mineral, and on but a single substance. It belongs to the disphenoidal class of the tetragonal system. This observation, verified by me in 1938 but not yet published, gave Cahn intense pleasure and made him more than ever proud of his namesake.

About the year 1920 Cahn became closely associated with Mr. Clarence Bement of Philadelphia, who after the sale of his magnificent collection of minerals to the American Museum of Natural History had taken up enthusiastically the assembling of a collection of micromounts. Cahn supplied him with a great variety of specimens to this end and learned from Mr. Fiss the delicate art of mounting them with the best effect. It was, I believe, from this association that his own interest in microminerals began, and he continued to prepare them up to within a few months of his death. He wrote me in 1937 that his micro-collection numbered over 3700 mounts representing 685 species. I was able to send him from time to time material of new minerals or new finds to add to this collection. Not only did he write most appreciatively of such additions but never failed to return to our collection some of the best mounts.

In his study of the micromounts he was able to make some interesting contributions to crystallographic knowledge, among others, in the field of orientated intergrowths of which he catalogued more than seventy combinations. He found, independently of others, the basal pinacoid on quartz from the rhyolite of the Thomas Range, Utah, and stimulated one of his students in the search which resulted in finding the same form in the quartz from the rhyolite of Ruby Mountain, Nathrop, Colorado.

So far as I can discover, Mr. Cahn published but one paper. This was entitled "Ueber Verwachsung von Topas-Granat und Rutil-Eisenglanz" and appeared in *Beiträge zur Krystallographie*, II, pages 7-9 (1919). This paper, which described for the first time the replacement of garnet by topaz at the Thomas Mt. locality and its orientated relation to the host, was written in 1913. His results were confirmed by a paper appearing with his article by Goldschmidt and Schroeder, which contains crystallographic data and a beautiful drawing of the intergrowth which Cahn had but sketched.

For many years Mr. Cahn had worked with younger men and boys who were interested in minerals, teaching them and helping them with their collections, and helped numerous mining men and prospectors in identifying their discoveries. This was usually with one individual at a time, but in 1933 he began to gather about him a number of younger men, science teachers, professional men and college students who had an interest in minerals, and to these he gave the rarest of privileges, first weekly and later semiweekly sessions in the study of minerals with the microscope. To each he gave hundreds of micromounts and stimulated in each an enthusiasm which has led to their adding hundreds more by their own collecting. There are now, among these pupils of Mr. Cahn, nine important micromount collections, each growing and each the beginning of a new circle of other and younger enthusiasts.

Several years ago Mr. Cahn was offered the chair of Mineralogy at Nebraska University. He refused the honor, perhaps partly because he had had no training in the art of teaching, but the members of his informal class all feel that he was one of the greatest teachers they have known.

Mr. Cahn's health began to fail in the fall of 1939 and, although he had periods of partial recovery so that he could return to his office and his beloved collection during the succeeding winter, he passed away on May 22, 1940, on the last day of his seventy-fifth year.

Lazard Cahn was vice-president of the Mineralogical Society of America in 1928. He did not often attend meetings of the Society during later years, but when he did he was always sought out by his older friends who loved to get him talking of his experiences with mineral dealers and collectors abroad and at home. His memory of events and of persons was wonderfully exact. And he seemed never to forget an outstanding specimen which had come to his attention, so that his appraisal of the value of a collection which he had examined was accurate and fair. Modesty as to his own great abilities was characteristic as was gentleness of speech and manner. In his death the science of mineralogy has lost a valued worker.

Mr. Cahn never married. He leaves a sister, Miss Nellie Cahn of San Francisco, to whom I am indebted for supplying much of the biographical material contained in this memoir. Mr. Willet R. Willis, an intimate friend of Mr. Cahn's in Colorado Springs, has also supplemented this information.

MEMORIAL OF PHILIP KRIEGER

Paul F. Kerr, *Columbia University, New York, N. Y.*

On August 18, 1940, while driving through the Adirondack Mountains, Philip Krieger was killed in an automobile accident. He was returning from North Creek, New York, where he had been visiting his wife and daughter at their summer home, to Gouverneur, New York, where he was engaged in summer field work. His sudden death was a severe shock to his family and many friends.

Philip Krieger was born in Portland, Oregon, November 22, 1900, the son of Philip and Katherine Elizabeth Hahn Krieger. He was one of a family of ten, having six sisters and three brothers. His parents were born in Russia, descended from Bavarian Germans who had migrated into the Russian Ukraine near Kiev about 1690. These emigrants maintained their own schools, churches, and laws, with little interference from Russian rulers. Eventually, around 1900, they emigrated to the United States, across the Pacific, and now form small groups, living in several widely separated communities along the west coast. To this day, these people speak German among themselves with a Bavarian dialect.

Philip Krieger became interested in mining at an early age, and for a short time before entering college he worked in the Slate Creek mining district of Alaska. His summer vacations, while attending Oregon State College, were occupied with work at the Bunker Hill and Sullivan mines in the Coeur d'Alene district of Idaho.

After obtaining his B.S. degree in 1925, he worked for two years as a mining engineer for the Phelps Dodge Corporation in Sonora, Mexico, and one year as chief engineer for the Ahumada Lead Company in Chihuahua, Mexico. This valuable experience was followed by a brief association with the St. Joseph Lead Company in southeastern Missouri before coming to Columbia University in 1928 as a graduate student in geology.

From 1928 to 1930, Dr. Krieger combined graduate study with departmental assistance work in mineralogy, and in the summer engaged in field work in the west. In 1930 he was granted a University Fellowship following which, in 1931, he was given an appointment as instructor in mineralogy. The Ph.D. degree was conferred upon him in 1932. In 1935, the chair of economic geology became vacant and Dr. Krieger was given the opportunity to take over the work in this field. He assumed this work with enthusiasm and vigor, being so successful that he was promoted to the rank of assistant professor in 1937.

Blackstone Studios

PHILIP KRIEGER
1900–1940

From 1931 to 1937, a period of increasing responsibility and attainment, Philip Krieger published his most important contributions to the study of mineral deposits. It was only natural for him to make economic geology his specialty, and with his early training in mining, he achieved a remarkable proficiency in the field within a comparatively short time. His publications were concerned mainly with silver, lead and zinc deposits of economic value. They were assisted materially by the excellent laboratory in mineralography which he had succeeded in building up at Columbia. In fact, the background that had been established presaged a brilliant future of scientific contribution when his career came to such an untimely end.

His summers during this period were spent in reconnaissance and exploration work for the American Metal Company in both Mexico and Canada, and in conducting student field trips in regions of economic importance. The summer of 1937 he attended the 17th International Geological Congress in Russia, making excursions to many Russian mineral deposits.

Philip Krieger became a member of the Mineralogical Society of America in 1931 and was elected a fellow in 1933; in 1934 he was elected a member of the American Institute of Mining and Metallurgical Engineers; in 1936 he was elected to fellowship in the Geological Society of America. He was a fellow of the Society of Economic Geologists and was particularly active in the affairs of that organization, being a member of the Council at the time of his death. He was also a fellow of the New York Academy of Sciences.

Philip Krieger was prominent in the affairs and meetings of the American Institute of Mining and Metallurgical Engineers. He was a member of the Papers and Publications committee, the Mining Geology committee, and the executive committee of the New York local section. He was often called upon to assist in the work of the committee in charge of the annual meeting of the Institute in New York.

In 1931, he married Medora Hooper, a graduate student in the Department of Geology at Columbia University and a daughter of Frank C. Hooper, manager of the Gore Mountain garnet mines at North River, New York. Many of their vacations and weekends were devoted to studies and recreation in the vicinity of North Creek, and in recent years they had become ardent devotees of the winter sport of skiing. While the University was in session Professor and Mrs. Krieger made their home in Scarsdale, New York, where their daughter, Katherine Elizabeth, was born in 1939.

Students and colleagues who worked with Philip Krieger always respected his appreciation of the broad principles involved in the study of mineral deposits, his quiet insistence upon accuracy and detail in the solution of problems, his patience in the examination and determination of minerals; nor will they soon forget his cheerful mien and love of fun. His was a charming personality that captivated all who came to know him. His passing is a deep loss to his family, friends, and science.

BIBLIOGRAPHY

Notes on an x-ray diffraction study of the series calcite-rhodochrosite: *Am. Mineral.*, **15**, 23–29 (1930).

Geology of the zinc-lead deposit at Pecos, New Mexico: *Econ. Geol.*, **27**, 344–364; 450–470 (1932).

An association of gold and uraninite from Chihuahua, Mexico: *Econ. Geol.*, **27**, 651–660 (1932).

(With Bird, Paul H.). Mounting polished surfaces in bakelite: *Econ. Geol.*, **27**, 675–678 (1932).

(With Agar, W. M.). Garnet rock near West Redding, Connecticut: *Am. Jour. Sci.*, (5) **24**, 68–80 (1932).

The occurrence of strontianite at Sierra Mojada, Mexico: *Am. Mineral.*, **18**, 345–350 (1933).

Primary silver mineralization at Sabinal, Chihuahua, Mexico: *Econ. Geol.*, **30**, 242–259 (1935).

Primary native silver ores at Batopilas, Mexico, and Bullard's Peak, New Mexico: *Am. Mineral.*, **20**, 715–723 (1935).

(With Balk, Robert). Devitrified felsite dikes from Ascutney Mountain, Vermont: *Am. Mineral.*, **21**, 516–522 (1936).

(With Fowler, G. M.). Mining geology: *Min. & Met.*, **19**, 11–13 (1938).

Review of "Geology and ore deposits of the Lordsburg mining district, New Mexico," by Samuel G. Lasky. *Econ. Geol.*, **34**, 731–732 (1939).

Bornite-klaphrothite relations at Concepcion del Oro, Mexico: *Econ. Geol.*, **35**, 687–697 (1940).

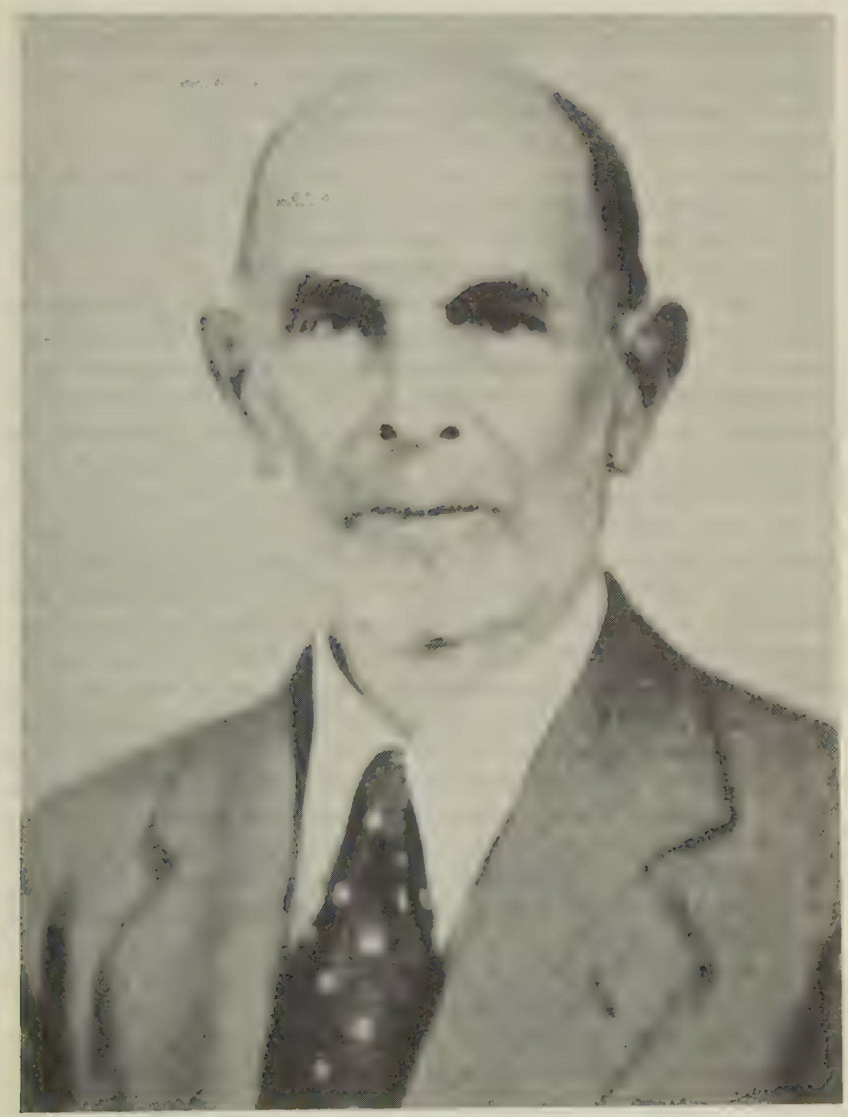
MEMORIAL OF JOHN ELIOT WOLFF

Charles Palache, *Harvard University, Cambridge, Mass.*

John Eliot Wolff, Professor of Petrography and Mineralogy Emeritus at Harvard University and past president of the Mineralogical Society of America, was born in Montreal, Canada, November 21, 1857. He died of heart failure in the Mojave desert, near Lancaster, California, on August 7, 1940.

Wolff had a life-long association with Harvard University. He graduated there with the class of 1879 and took his A.M. and Ph.D degrees there also, the latter in 1889. He taught there as Instructor, Assistant Professor, and Professor from 1887 to 1923. In a memorial to Wolff to be published in the *Proceedings of the Geological Society of America* with full bibliography I have told of the various activities in the geological field which filled his early life, aside from teaching. Here I will confine myself to an account of his work in the special field of mineralogy.

In 1894 there was inaugurated at Harvard a new Department of Mineralogy and Petrography with Wolff at its head. Up to that time such instruction as was given at Harvard in mineralogy was offered by Professor J. P. Cooke in the Department of Chemistry. Wolff had begun teaching petrography in 1887 as a member of the geological staff. Professor Cooke, shortly before his death in 1894, had secured funds for the erection of a section of the Museum of Natural History and had installed there the mineral collection, in which he had long had a deep interest. Wolff became Curator of this Museum when the new Department was formed, and thenceforth devoted a large part of his time to its care and improvement. He was teaching both petrography and mineralogy when I joined the staff late in the year 1895. The equipment for mineralogical instruction was inadequate. Except for a small teaching collection of minerals, everything that the Museum possessed was in the public exhibition cases, where there was a great deal of duplication. It was the writer's first task to rearrange and concentrate the specimens on exhibition, and the duplicates thus removed formed the beginning of a research collection. After a few years I took over all the mineralogy instruction except that in optical crystallography, which Wolff continued to teach together with petrography. There were but small funds with which to purchase either minerals or equipment, and Professor Wolff gave generously from his private means to increase the collections and to develop the laboratory for research. In 1904 he purchased the entire stock of rocks and minerals of George Frazer of Medford, Massachusetts. I recall the scene when, returning from an absence, I found about ten tons of



Bennett, Pasadena

John Eliot Wolff
1857–1940

material filling the basement floor—piles of rock specimens trimmed and untrimmed and miscellaneous cases made from old boxes filled with mineral specimens. This purchase gave the elementary classes in mineralogy a supply of splendid material for study which even today is not exhausted. The rocks went into the study trays of elementary geology.

Wolff also experimented with lighting the Museum and laboratories more adequately. At his own expense he installed Nernst lamps, then the best form of incandescent light, which served their purpose admirably for many years. He equipped a chemical laboratory for quantitative analysis, and there made many rock and mineral analyses.

In 1900 Wolff spent a year of sabbatical leave in Germany, working chiefly in the chemical laboratory of Professor Groth in Munich. He returned with a huge supply of the latest chemical apparatus and with cases of fine minerals for the Museum. All of these gifts and many others were made without display, his annual reports to the President of the University simply reporting them as from an anonymous donor or from a friend of the Museum.

Professor Wolff introduced me to the study of the Franklin Furnace minerals while he was at work on the Folio of that region for the U. S. Geological Survey. He found there and described the new mineral species hardystonite, which proved to be an important constituent of the ore. He also analyzed and described zinc-schefferite from the same locality. He analyzed the purple apatite of Auburn, Maine, in 1902 and a new chlorite from Wyoming in 1912. A considerable part of his chemical and optical research was devoted to the minerals of the Crazy Mt. rocks. This work continued after his retirement, so far as regards optical investigation, in the private laboratory which he set up in his Pasadena home. His final summary of this life work was presented informally as his Presidential address to the Mineralogical Society of America in 1934. It was published in 1938 in the *Bulletin of the Geological Society of America*, his last published paper.

The rock type *theralite* was named by Rosenbusch from specimens Wolff took to Heidelberg in 1880.

Professor Wolff's most important contribution to the development of the Department of Mineralogy and Petrography at Harvard was in securing the Holden endowment. Albert F. Holden, who graduated in 1888, was a very successful mining engineer. Early in his professional career he began to collect the minerals found in his mines and ultimately accumulated an important collection. Holden intended his minerals to go to Harvard and therefore kept in close touch with Wolff in order that his collection might supplement rather than duplicate the Harvard cabinet. When in 1913 Holden realized that his career was destined to come to an untimely end through an incurable disease, he conferred with Wolff as to the form and wording of the munificent bequest with which he had determined to endow the Harvard Mineralogical Museum. He died before the end of the year, and his minerals came at once to the university. Professor Wolff, during the next few years, spent all his free time incorporating into the exhibition cases the more striking specimens from Holden's collection.

It was not until nine years after Holden's death that the trustees of his estate were able to turn over to the university the endowment fund. When it had been received in 1922, Wolff decided that the event marked a proper termination of his active service to the Museum and the Department of Mineralogy and Petrography. He, therefore, retired at commencement, 1923, and left to the writer the acceptable task of carrying out the intent of Mr. Holden, to raise the Harvard Mineralogical Museum to an equality with the best, a task made possible by the generous funds provided. Wolff also gave his own considerable estate, subject to a life annuity, to the University in the form of the John E. and Philip Wolff Fund, the income of which, after his death, was to be devoted to the growth and use of the collection to which he had devoted so large a part of his life.

Upon his retirement in 1923 Professor Wolff disposed of his property in the east and removed to Pasadena, California. Here, in a charming home, he spent the remainder of his years. At first he had the companionship of an older brother and his wife, but they died after a few years and thenceforward he lived alone. He continued his studies of the Crazy Mt. rocks and minerals, but during the cooler winter months spent much time on trips to Death Valley and other parts of the desert regions of southeastern California. His car was equipped for camping and he often went alone for short periods of life in the open. He continued these trips even after advancing age, failing eyesight and weakened heart made it, in the eyes of his friends, seem most unwise. And so it proved to be. On August 7 he went alone to spend the night at a granite knob known as Hivista, 25 miles east of Lancaster in the Mojave desert. He did not return the next day and was not found until five days later. Hoyt S. Gale, an old student under Wolff and a devoted friend, when he learned the place for which Wolff had started, remembered having been there with him two years before. He led the Sheriff's car to the spot where they found Wolff dead in his car. The car was trapped in a sandy spot near the road, and it was evident that the effort Wolff had made to clear the wheels had overtaxed his heart. He had managed to get back into the car before the end came. But it does not appear that Wolff suffered or that he lingered long. After all, he died doing what he liked best to do.

We may feel that Wolff made no very notable contribution to the subjects which occupied his long life. But his many students remember his sound teaching, his kind counsel, his gentleness; and his influence will live long by reason of the broad and firm foundation which he constructed for the Harvard Department of Mineralogy and Petrography which he established. He lived long enough to know that his work would long survive him.

PROCEEDINGS OF THE TWENTY-FIRST ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA AT AUSTIN, TEXAS

PAUL F. KERR, *Secretary.*

The twenty-first annual meeting of the Society was called to order Thursday, December 26th, at 2:00 P.M. in Room 315–316, of the Students Union Building at the University of Texas, Austin, Texas, president William F. Foshag presiding. The customary business of the society was conducted, including reports of the officers of the society and committees, summarized as follows:

MINUTES OF THE TWENTIETH ANNUAL MEETING, 1939.
REPORT OF THE SECRETARY.
REPORT OF THE EDITOR.
REPORT OF THE TREASURER.
REPORT OF THE AUDITING COMMITTEE.
MEMORIALS TO W. C. BRÖGGER, LAZARD CAHN, PHILIP KRIEGER, AND J. E. WOLFF, PRESENTED BY DEAN EDWARD H. KRAUS.

The business meeting was immediately followed by the scientific session. The report of the election of officers and fellows for 1941, and the reports of the officers are given in the following pages.

ELECTION OF OFFICERS AND FELLOWS FOR 1941

The secretary announced that 310 ballots had been cast for the officers of the Society as nominated by the Council. The officers for 1941 are:

President: Fred E. Wright, Geophysical Laboratory, Washington, D.C.
Vice-President: William J. McCaughey, Ohio State University, Columbus, Ohio.
Secretary: Paul F. Kerr, Columbia University, New York, N.Y.
Treasurer: Earl Ingerson, Geophysical Laboratory, Washington, D.C.
Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.
Councilor, 1941–44: M. A. Peacock, University of Toronto, Toronto, Canada.

The secretary announced that according to the provisions of the constitution, the following have been elected to fellowship in the Mineralogical Society of America:

Ahlfeld, Friedrich, La Paz, Bolivia.
Bannister, Frederick A., British Museum of Natural History, London, England.
Bastin, Edson S., University of Chicago, Chicago, Illinois.
Butler, Robert D., Lehigh University, Bethlehem, Pennsylvania.
Cooke, S. R. B., Montana School of Mines, Butte, Montana.
Faust, George T., U. S. Department of Agriculture, College Park, Maryland.
Frondel, Clifford, Harvard University, Cambridge, Massachusetts.
Ito, Teiichi, Imperial University, Tokyo, Japan.
McConnell, Duncan, University of Texas, Austin, Texas.
Meen, V. Ben, University of Toronto, Toronto, Canada.
Miser, Hugh D., U. S. Geological Survey, Washington, D.C.
Murdoch, Joseph, University of California at Los Angeles, California
Pettijohn, Francis J., University of Chicago, Chicago, Illinois.
Schwartz, George M., Laval Université, Quebec, Canada.

REPORT OF THE SECRETARY FOR 1940

To the Council, Fellows, and Members:

MEMBERSHIP STATISTICS

	1939	1940
Correspondents	8	7
Fellows	184	191
Members	484	457
Subscribers	366	334
	1042	989

GAIN AND LOSS FOR 1940

	Gain	Loss
Correspondents	0	1
Fellows	15	8
Members	122	149
Subscribers	80	112
	217	270

During 1940, due to disturbed international conditions affecting many members and subscribers in foreign countries, the Mineralogical Society of America suffered a net loss in membership of 53, or 5% on the basis of the 1939 total. This, actually, is less of a loss than might normally have been expected in view of the foreign situation. The total membership which last year passed the 1000 mark has this year dropped slightly below it.

Respectfully submitted,
PAUL F. KERR, *Secretary*

REPORT OF THE EDITOR FOR 1940

To the Council, Fellows and Members of the Mineralogical Society of America:

From all external appearances it would seem that the Society's publication for 1940 has experienced a normal year. Volume 25 with its total of 828 pages is slightly larger than volume 24 of 1939. The current volume has been exceeded in size on only three occasions, in 1935, 1937 and 1938, and on two of these occasions special Harvard issues were largely responsible for these exceptional volumes.

However, it must be admitted that the calamity that has befallen both Europe and Asia has affected the Society and its publication from the financial standpoint. Foreign advertisers have all canceled their contracts as American markets are no longer open to their products. And in a more serious manner the wars abroad have influenced the service of the Journal. A very large number of subscribers have been unable for one reason or another to continue their subscriptions this year. This in itself represents a substantial monetary loss in income. What the future holds in store is too uncertain to even hazard a guess at the present time. Some type of retrenchment may be in order and along this line it might be mentioned that the Editor during the past year, on a number of occasions, has asked the author or his college to assume a portion of the cost when publication of the article in question, either due to its intricate character or excessive number of illustrations, would otherwise have placed too heavy a financial burden upon the Society. It should be stated, however, that this restrictive measure is a temporary arrangement and will be modified when world conditions become more normal. But for the time being it seems a wise protective measure to adhere to.

An innovation started this year, which I hope will meet with the approval of the readers of the Journal, is the insertion whenever possible of an abstract to accompany the longer contributions. This abstract, prepared by the author, permits the reader to become acquainted with the main points prior to the reading of the article itself. Also it is a great aid to abstractors of other journals who can quote the abstract, or a portion of it, and be assured that the essential points have not been overlooked.

As indicated previously volume 25 contains 828 pages exclusive of the index. Nearly 82% of the total space of the Journal is devoted to leading articles which this year number 60. While a few of these major contributions are rather long, the average length is only 11.3 printed pages. From an examination of Table 1 which accompanies this report it will be noted that in the classification of these 60 papers in the various fields covered by our Journal, descriptive mineralogy leads the list with 16 articles, followed by petrography and geometrical crystallography. If to these main articles we add 20 shorter papers that were accepted, we obtain a total of 80 published manuscripts for the calendar year. These contributions were received from 79 contributors associated with 48 different universities, research bureaus and technical laboratories.

Each year the number of mineral species is increased by the discovery of naturally occurring inorganic compounds not previously described. *The American Mineralogist* for 1940 carried detailed descriptions of seven of these new minerals: gratonite, overite, montgomeryite, bellingerite, sterrettite, pararammelsbergite and clinobarrandite.

One noteworthy phase that should be stressed is the number of papers received this past year from sources outside of the United States. A new record was established in this regard which is surprising perhaps when we consider the disturbed conditions abroad. But

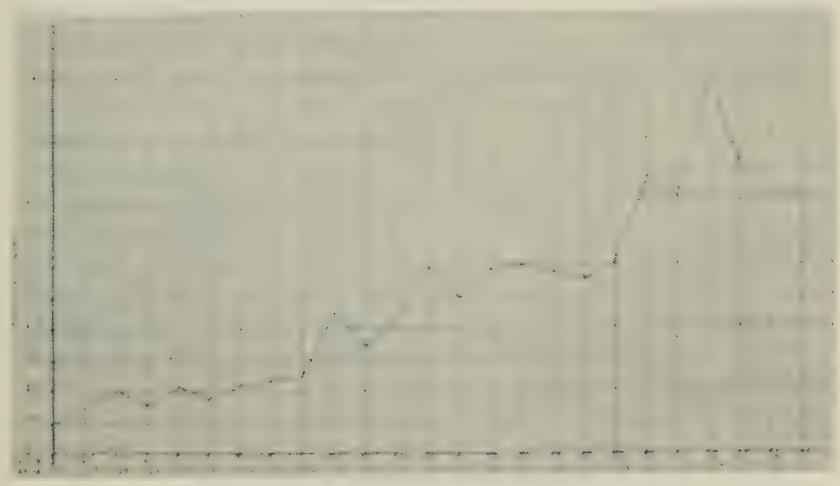


FIG. 1

with the activity of many European publications curtailed it is but natural if some authors in foreign lands should seek outlets elsewhere. Of the 80 published manuscripts of the year, 17 (13 major articles and 4 shorter ones) were received from the following 8 countries: Canada, Australia, Peru, The Netherlands, Japan, New Zealand, Colombia and South Africa.

Realizing that a report covering a single year is at best quite inadequate to appraise the general service rendered by the Journal, friends of the Society might be interested in a few facts covering the operation of *The American Mineralogist* for a longer period, from 1931 to 1940 inclusive. In the past decade *The American Mineralogist* has printed 7,768 pages, not including the 98 page decennial index. During this ten-year period 640 leading articles have appeared, 67 of which represent contributions from the following 15 countries: Canada 28; England 8; Australia 4; Belgium 4; Germany 3; Sweden 3; Japan 3; Soviet Russia 3; The Netherlands 3; Norway 2; Czechoprotectorate 2; and one each from China, Switzerland, Peru and New Zealand.

Figure 1 is a graph illustrating the growth of the Journal from 1916 to the present time. It will be noted that for the past six years *The American Mineralogist* has published volumes in excess of 800 pages. The special "Palache number," financed largely by friends of Harvard University, was responsible for the high peak reached in 1937.

The accompanying table of contents summarizes in detail the distribution of subject matter in volume 25.

TABLE 1. DISTRIBUTION OF SUBJECT MATTER IN VOLUME 25

Subjects	*Articles*	*Pages*	*Per Cent of Total*
Leading articles*			
Descriptive mineralogy	16		
Chemical mineralogy	7		
Structural crystallography	6		
Mineralography	1		
Geometrical crystallography	9		
Petrography	10		
Optical mineralogy	2		
Memorials	5		
Miscellaneous	4		
	60	678	81.9
Short articles	20	59½	18.1
Proceedings of societies	17	63½	
Notes and news	18	6½	
Abstracts of new mineral names	34	10½	
Book reviews	13	10	
Total entries	162	828	100.0
Illustrations	254		
Index, covers, advertisements		90	
Total		918	

* (Average length of leading articles, 11.3 printed pages.)

Respectfully submitted,
WALTER F. HUNT, *Editor*

REPORT OF THE TREASURER FOR 1940

To the Council of the Mineralogical Society of America:

Your Treasurer submits herewith his annual report for the year beginning December 1, 1939, and ending November 30, 1940.

RECEIPTS

Cash on hand December 1, 1939	$ 2,219.95
Dues and subscriptions	2,785.58
Advertisements	305.82
Sale of back numbers	297.98
Authors' charges on separates	527.74
Interest on endowment (bonds)	2,312.00
Interest on endowment (stocks)	170.00
Sale of 20-volume index	15.26
Geological Society of America grant for 1940	1,500.00
Partial payments (1940) on principal of Trenton Mortgage Service Company's preferred stock	190.00
Principal of called (at 107½) Union Pacific Railroad Co., First lien and ref. mtg. 4% bonds, due June 1, 2008, less bank collecting charge of $1.39	1,073.61
	$11,397.94

DISBURSEMENTS

Printing and distribution of the Journal (12 issues)	$ 5,844.18
Printing and distribution of separates	736.52
To the Editor, Secretary, and Treasurer	970.00
Postage	113.35
Printing	125.39
Stationery	3.20
Clerical help	243.94
Committee expenses	2.74
Safety deposit box	8.25
Bank collecting charges	3.66
Telegrams	7.74
Refund of dues	2.75
Checks returned	16.00
Canadian war tax	1.08
Reinvestment of endowment money (20 shares Union Pacific Railway pfd. stock)	1,607.75
	9,686.55
Cash balance November 30, 1940	1,711.39
	$11,397.94

The endowment funds of the Society as of November 30, 1940, consist of the following securities:

4 $100 bonds, Great Northern Railway Co., Genl. mtg. 5½%, due January 1, 1952	$ 400.00
45 $1,000 bonds, City and County of Honolulu, Territory of Hawaii, Water Works, 5%, due April 15, 1954	45,000.00
37-514/1000 shares, Trenton Mortgage Service Co., Trenton, N.J., preferred stock	3,059.90
5 shares, American Telephone and Telegraph Co., common stock	620.57*
5 shares, Public Service of New Jersey, 8% preferred stock	702.00*
5 shares, United States Steel, 7% preferred stock	502.45*
10 shares, Consolidated Edison, 5% preferred stock	1,066.64*
20 shares, Union Pacific Railroad Co., 4% preferred stock	1,607.75*
	$52,959.31

* Purchase price.

Respectfully submitted,
WALDEMAR T. SCHALLER, *Treasurer*

DANA FUND

Statement of the Special Dana Fund of the Mineralogical Society of America, initiated by Prof. E. S. Dana, and since his death cared for by the Treasurer. Disbursement normally made to the daughter of Prof. F. Berwerth, in Vienna. During the fiscal year 1940 it has not been possible to make any disbursement.

RECEIPTS		
Available balance, November 30, 1939	$816.80	
Interest	16.08	
Refund on uncashed check	45.00	
		$877.88
DISBURSEMENTS		
Disbursed	$ 0.00	
Available balance, November 30, 1940	877.88	
		$877.88

Respectfully submitted,
WALDEMAR T. SCHALLER, *Treasurer*

REPORT OF THE AUDITING COMMITTEE

To the President of the Mineralogical Society of America:

The Auditing Committee has examined and verified the accounts and report of the Treasurer of the Mineralogical Society of America, for the fiscal year ending November 30, 1940. The securities listed in the Treasurer's report, with all future coupons on the coupon bonds attached, are in the safety deposit box at the American Security and Trust Company of Washington, D.C.

Respectfully submitted,
EARL INGERSON, *Chairman*
E. P. HENDERSON
E. F. OSBORN

ANNUAL LUNCHEON, MINERALOGICAL SOCIETY OF AMERICA

The annual luncheon of the Mineralogical Society of America was held in the Students Union Building of the University of Texas, Austin, Texas, at 12 noon on Thursday, December 26, 46 members and friends of the society being present. President William F. Foshag presided and served as toastmaster during the presentation of the Roebling Medal. Dr. A. N. Winchell of the University of Wisconsin presented the Third Roebling Medal to Dr. L. J. Spencer, former Curator of Minerals at the British Museum. Dr. Spencer was unable to be present to receive the medal, due to present world conditions. However, Mr. Harold E. Slaymaker, British Consul in Houston, Texas, received the medal in his behalf, reading Dr. Spencer's response.

PRESENTATION OF PAPERS

TEKTITES*

VIRGIL E. BARNES

Tektites are etched pebbles of acidic glass mostly black and lustrous in reflected light and bottle-green, smoky, or brown in trasmitted light. They are found in siliceous gravels of Miocene to Pleistocene age. Tektites are found in Czechoslovakia, Australia, Indo-China, Philippine Islands, Dutch East Indies, Siam, China, Ivory Coast, and possibly in South America. In North America, tektites were recognized first in 1936 (*Univ. Texas Pub.* 3945, 477–582, 1940).

Tektites have an excellent flow structure outlined by adjacent schlieren of different chemical compositions. These heterogeneous glasses etch differentially producing the weathered surface distinctive of tektites. In obsidian the flow structure is outlined by crystallites and vesicles and not by difference in composition of the glass; consequently etched obsidian is free of fine flow lines and resembles tektites only in the coarser etch markings.

Tektites definitely are not of an igneous origin. This fact led indirectly to the prevalent assumption that they are meteorites. Chemically tektites correspond closely to clastic sedimentary rocks ranging from shale to sandstone in composition. The writer identified small included glass particles in tektites as lechatelierite. These lechatelierite particles must have been originally grains of quartz or other non-hydrous silica. These grains were melted during the process of tektite formation. Their presence probably excludes a meteoritic origin.

Lightning may produce tektites. Glass formed by power line short circuits through soil contains lechatelierite particles. This glass very closely resembles tektite glass and when artificially etched develops a typical tektite-like surface. Observations are needed on the effect of lightning upon clastic sedimentary rocks and their soils.

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* Presented through the Geological Society of America.

THE STRUCTURAL CELL OF JORDANITE

L. G. BERRY

Single crystal *x*-ray photographs on a cleavage fragment (sp. gr. 6.44) from Binn, Switzerland, give a simple monoclinic lattice in which the cell with the shortest edges has the dimensions:

$$a_0\ 8.89 \pm 0.03,\ b_0\ 31.65 \pm 0.03,\ c_0\ 8.40 \pm 0.02;\ \beta\ 118°21'$$

Space group C_{2h}^2—$P2_1/m$ or C_2^2—$P2_1$. In this lattice the structural cell given by Richmond has the edges $a' = [\frac{1}{2}01]$, $b' = [010]$, $c' = [\bar{\frac{1}{2}}00]$. This cell is a half unit cell and is therefore inadmissible. The new cell content is:

$$Pb_{27}As_{14}S_{48} = 27PbS \cdot 7As_2S_3$$

with the calculated sp. gr. 6.49, rather than:

$$Pb_{28}As_{14}S_{49} = 7[4PbS \cdot As_2S_3]$$

This cell content, which is not divisible by two, reconciles the several half-cell contents obtained by Richmond (1938) and by Fisher (1940).

ORE-BEARING PIPES IN THE TARRYALL RANGE, COLORADO

ROBERT D. BUTLER AND L. B. RILEY

A number of small pipe-like deposits in red granite have been opened by prospectors on the western slope of the Tarryall Range. Their diameters range from five to eight feet and an ideal cross-section is circular, although it may be oval, semicircular, or rectangular. Metallic minerals present are: earthy hematite, pyrite, sphalerite, galena, chalcopyrite, and molybdenite. Gangue minerals are quartz, muscovite, and fluorite. Concentric alteration zones surrounding the pipes consist of bleached and silicified granite. Although pneumatolysis may have played a role in the formation of the pipes, an explanation involving only hydrothermal deposition is also tenable. The deposits resemble in most respects certain tin-bearing pipes in South Africa.

INTERFERENCE FIGURES IN CONVERGENT LIGHT

J. D. H. DONNAY

The usefulness of plans and elevations in the study of geometrical crystallography has been excellently demonstrated by A. F. Rogers (*American Mineral.* **8,** 19-31, 1923). The same methods of descriptive geometry can be applied with profit in optical crystallography, especially to the study of interference figures.

It is also proposed to use two meridional cross-sections, at right angles to each other and at 45° to the cross-hairs, through the surface of retardation. The *retardation curves* so obtained are helpful in explaining the motion of lines produced by the quartz wedge. (In the case of a biaxial crystal, sliced normal to the acute bisectrix, for instance, the *retardation curves* are drawn for the plane of the optic axes and for the plane of the acute bisectrix and the optic normal.)

REPRESENTATIVES OF THE BROOKITE SPACE-GROUP

J. D. H. DONNAY

The brookite space-group is D_{2h}^{15} (*Pcab* or *Pbca* according to crystal orientation). The morphological expression of this space-group is seen in the following characters: (1) No *double zone* is present. (2) All three central zones, [(*hkk*)], [(*lkl*]), [(*hhl*)], are *simple zones*, intersecting in a common dominant face, to be taken as (111). (3) All three axial zones, [(0*kl*)], [(*h*0*l*)], [(*hk*0)], are *simple zones* with dominant face "shifted" from unit position toward a pinakoid; the shifts are cyclic, either toward *c*, *a*, *b*, with dominant faces (012), (201), (120), respectively (orientation *Pcab*), or toward *b*, *c*, *a* with dominant faces (021) (102), (210), respectively (orientation *Pbca*).

These criteria need not all be present (as they are in *brookite**) to permit space-group identification. Thus, if only two central zones are developed, both simple, with a common dominant, the lattice is determined as primitive (examples: *scorodite, reddintite*). The unit-face (111) may be inferred from the dominant faces in the axial zones, using the rule that the dominant face in an axial zone must be either at unit distance, or at half the unit, or at twice the unit (examples: *hambergite*,* *sulfamic acid**). Very scant morphological information may suffice to point out the space-group (examples: *strengite, sulfamic acid*,* *oxalic acid**), especially if use be made of the generalization of the Law of Bravais.

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* For the species marked with an asterisk, the space-group has been determined by *x*-rays; it agrees with the morphological result.

THE PROBLEM OF THE VARIATION IN CINNABAR COLORATION

ROBERT M. DREYER

Cinnabar varies in color from orange red to dark purple. This variation in cinnabar coloration is independent of (1) the size of the cinnabar aggregates, (2) variations in crystal structure, (3) any spectrographically detectable quantitative or qualitative differences in elemental concentrations, and (4) the total impurity concentrated in solid solution in the cinnabar. The cause of the variation in cinnabar coloration therefore is, as yet, indeterminate.

PETROGRAPHIC STUDY OF THE NEW MONT LAURIER-SENNETERRE HIGHWAY

(Preliminary Report)

CARL FAESSLER

The new highway crosses over 100 miles of unexplored territory, from Mont Laurier (82 miles due north of Ottawa) northwest to the Abitibi mining district. It connects two formations of doubtful relative age: the Grenville limestone, in the south, and the Keewatin gold-bearing greenstones (altered lavas), in the north.

(1) For the first 20 miles, the highway shows the continuation of the typical Grenville crystalline limestone and garnetiferous paragneiss, which underlies the Mont Laurier area. (2) Then the limestone disappears completely, while another gneiss is encountered characterized as follows: absence of garnets, well-marked foliation, and evidence of granitization. This gneiss was followed by the author for 60 miles; Aubert de la Rüe* traced it 25 miles farther, clear to the Temiskaming sedimentary schists and graywackes, which border on the Keewatin of the Abitibi region. (3) Basic dikes cut through all rocks along the highway; more numerous toward the south, they trend south-east, toward a large anorthosite body (Morin series), of which they are considered offshoots.

The new gneiss reported may prove to be a migmatite, resulting from the alteration of a more argillaceous facies of the Grenville, with igneous additions. A source of magmatic liquid was available for the granitization, as proved by the presence nearby of acidic stocks (Pine Hill, Guenette, Labelle, Rolland), known to be differentiates of the main Morin intrusive.

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* Private communication.

CONSTITUTION AND POLYMORPHISM OF THE PYROAURITE AND SJOGRENITE GROUPS

CLIFFORD FRONDEL

The carbonate-hydroxides, pyroaurite, stichtite and hydrotalcite are shown by x-ray study to be isostructural. The dimorphism suggested by Aminoff and Broomé in 1930 for pyroaurite is definitely proven, and is shown to extend to stichtite and to hydrotalcite. Rhombohedral and hexagonal groups are recognized which each conform to the formula $R_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$, where $R = Fe$, Al or Cr. Data for the six species involved, three here being described as new, follow:

Rhombohedral or Pyroaurite Group

	Cell Contents (Hexagonal unit)	a_0	c_0	ω	ϵ	Proven Localities
Pyroaurite	$3(Fe_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$	6.19	46.54	1.564	1.543	8
Stichtite	$3(Cr_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$	6.18	46.38	1.545	1.518	3
Hydrotalcite	$3(Al_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$	6.13	46.15	1.511	1.495	4

Hexagonal or Sjogrenite Group (New)

Sjogrenite	$Fe_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$	6.20	15.57	1.573	1.550	1
Barbertonite	$Cr_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$	6.17	15.52	1.557	1.529	3
Manasseite	$Al_2Mg_6(OH)_{16}CO_3 \cdot 4H_2O$	6.12	15.34	1.524	1.510	3

The structural cells found by single-crystal and powder x-ray methods have the cited values of a_0 and c_0 halved for the rhombohedral series and a_0 halved for the hexagonal series. The dimensions here given are required for rational cell contents. Dimensionally $c_{0(\mathrm{rh.})}$: $c_{0(\mathrm{hex.})} = 3:1$, and the halved value of a_0 for both series (*ca.* 3.1) is nearly identical with $a_0 = 3.12$ of brucite.

The minerals are lamellar on {0001}, often with a partially or completely random stacking of micro-crystals about [0001]. The rhombohedral and hexagonal analogues very commonly occur intimately admixed, and in part are mutually oriented in parallel position. Brugnatellite, $FeMg_6(OH)_{16}CO_3 \cdot 4H_2O$, is distinct from the minerals at hand, and the identity of houghite with hydrotalcite (actually manasseite) is confirmed. New localities for pyroaurite include Val Malenco and Val Ramazzo, Italy, and the first American occurrence, at Blue Mont, Maryland.

WHITLOCKITE: A NEW CALCIUM PHOSPHATE, $Ca_3(PO_4)_2$

CLIFFORD FRONDEL

Whitlockite is anydrous tricalcium phosphate, $Ca_3(PO_4)_2$, with Ca substituted for by Mg (Mg:Ca = 1:13) and Fe (Fe:Ca = 1:17). Rhombohedral, probably scalenohedral—$\bar{3}\,2/m$, with $a:c = 1:3.547$. Habit rhombohedral $\{01\bar{1}2\}$, with minor {0001}, $\{10\bar{1}4\}$, $\{11\bar{2}0\}$. Structure cell: $a_0 = 10.25 \pm 0.03$, $c_0 = 36.9 \pm 0.2$; $a_0:c_0 = 1:3.600$; $a_{rh} = 13.65$, $\alpha = 44°6\frac{1}{2}'$. Cell contents in the rhombohedral unit $Ca_{21}P_{14}O_{56}$. Space group (Weissenberg method) probably $R\bar{3}c$. No cleavage. Hardness 5. Specific gravity 3.12 (obsvd.), 3.19 (calc.). Colorless and transparent. Uniaxial—(neg.), with $\omega = 1.629 \pm 0.002$, $\epsilon = 1.626 \pm 0.002$ (for Na). The mineral is structurally distinct from graftonite and apatite.

Whitlockite occurs in the Palermo granite pegmatite near North Groton, New Hampshire, as a late hydrothermal mineral in the following association and sequence: whitlockite and quartz—rhodochrosite—apatite—zeolite. The mineral is named after Herbert P. Whitlock, a former president and secretary of this society and at present Curator of Minerals and Gems in the American Museum of Natural History.

SPATIAL DISTRIBUTION OF MINOR ELEMENTS IN SINGLE-CRYSTALS

C. FRONDEL, W. H. NEWHOUSE, R. F. JARRELL

It is shown spectrographically that the minor foreign elements present in single-crystals of galena, calcite and other species are not uniformly dispersed throughout the host crystal, but generally are distributed in adjoining or alternating regions of greater and lesser concentration. These concentration-regions are related to the growth surfaces of the host crystal, and fall into two types: (a) Pyramidal regions subjacent to particular faces on crystals bounded by several crystallographically different forms. The concentration differences arise in the unequal adsorptive capacity of the different forms on the growing crystal for the foreign elements in question. (b) Alternating bands parallel to the growth surfaces without any or marked selectivity as to the crystallographic kind of surface.

The spectrographic work on galena revealed that both Ag and Si are relatively concentrated in the growth regions subjacent to the octahedral faces of cubo-octahedrons. Other minor elements, including Cu, Fe, Al, Cr, Ba, Sr, Ca and Mg, show significant quantitative variations within galena single-crystals but apparently without any special relation to the morphology. Staining of sectioned and polished single-crystals develops a complex internal structure outlined by relatively reactive, dark stained, growth bands and segments. Correlated spectrographic examination indicates that the dark stained regions are enriched in Ag. The growth history of crystals from many different localities shows a general similarity: an early stage of octahedral, Ag-poor, galena followed by the appearance and gradual increase of cube faces with the concomitant deposition of Ag-rich galena in bands or segments especially upon the octahedral faces.

Spectrographic examination of calcite single-crystals further illustrates the features of distribution found with galena. Significant compositional variations are found between successive growth zones in habit-invariant single crystals and between overgrown crystals of different habit. No special connection, however, could be traced between the morphology, color or growth history of the crystals and any of the foreign elements tested (Fe, Cu, Mn, Al, Sr, Mg).

The factors (temperature, concentration, pH, rate of growth, morphology, etc.) which determine the partition coefficient between the minor element content of the mother solution and the growing host crystal and their bearing on the minerogenetic interpretation of spectrographic and other analyses are discussed.

A STUDY OF THE BORDER ROCKS OF A GRANITE BATHOLITH, RED LAKE, ONTARIO

WILFRID K. GUMMER

Granites intrusive into volcanic rocks in the Red Lake area are commonly surrounded by a gradational zone of more basic rocks. The granite in such areas is rich in inclusions of gabbroic and dioritic composition. Inclusions are both rounded and angular and vary greatly in size; the more altered ones are the more faded. A detailed investigation of such an occurrence in the Mackenzie Island area was carried out and forms the basis of this paper.

The study of the petrography of the main granite of the Mackenzie batholith, of the volcanic rocks and of the intermediate or border rocks, has brought out several points which bear upon the origin of the border rocks. Most important is the formation in the granite and the border rocks of late potash minerals.

Rosiwal analyses were made on a suite of rocks passing from the main granite through the border facies into andesitic rock. Mineral and oxide components when plotted against silica yield curves indicating that the border rocks are truly intermediate between the granite and volcanic rock, in composition. The conclusion is reached that the border rocks are the result of contamination of the granite magma by the introduction of numerous inclusions of the country rock. Textures and mineralogical assemblages indicate reaction between the liquid and solid phases.

THE NATURE OF ARITE

RALPH J. HOLMES

Uncertainty has long existed concerning the validity of the mineral arite or the natural occurrence of intermediate members of the system Niccolite, NiAs—Breithauptite, NiSb. Intermediate members of this isomorphous series can be produced synthetically. Further x-ray study of synthetic intermediate members of this series and x-ray and microscopic examination of natural material from several occurrences including the type locality at Ar in the Pyrenees indicates that a mineral intermediate between niccolite and breithauptite exists in nature. It is believed that this material may be properly designated as arite.

AN OCCURRENCE OF PINITE ROCK

PAUL F. KERR AND WILLIAM W. LOMERSON

A large mass of sericite, samples of which invert to mullite on calcination, occurs in the Humboldt Range, Nevada. Associated with the sericite are alumino-silicates, which it is believed are responsible for the unusual thermal behavior. The mass is thought to have been originally a fine tuff or ash which has been altered by hydrothermal metamorphism to a rock consisting in large part of finely crystalline potash mica. The name pinite is suggested as a rock term to be applied to such a mass. The principal associated rock units of the area are rhyolitic volcanics of the Koipato formation overlain by the Middle and Upper Triassic Star Peak limestones. The pinitized zone lies near the crest of a northward trending ridge on the south side of South American Canyon just below the contact between the volcanics and the limestones in a member of the series similar to the Rochester trachyte of Knopf.

Topographic and geologic maps of the deposit have been prepared and laboratory examination has involved microscopic, *x*-ray, and chemical study.

A NEW HYDROUS TUNGSTEN OXIDE FROM ORURO, BOLIVIA

PAUL F. KERR AND FORD YOUNG

The oxidation of ferberite from this locality has resulted in the formation of two hydrous oxides of tungsten. Previous descriptions of the deposit have mentioned the occurrence of tungstite, $WO_3 \cdot H_2O$. Recent studies indicate that a second oxide is present. *X*-ray and optical examinations show that this material differs in structure from the recorded descriptions of tungstite and chemical investigation indicates that it contains two molecules of water. Since this mineral appears to be an intermediate product in the alteration of ferberite to tungstite and since it resembles tungstite in many of its physical properties, the name *hydrotungstite* is suggested.

AN INTERESTING DISTORTED DIAMOND CRYSTAL

EDWARD H. KRAUS AND CHESTER B. SLAWSON

A 5.1 carat industrial stone which is a distorted octahedron with "prismatic" development is described. The orientation and distribution of the natural etch figures on the various faces are discussed.

ROLE OF HARDNESS AND STRUCTURE IN THE SHAPING AND USE OF INDUSTRIAL DIAMONDS

EDWARD H. KRAUS AND CHESTER B. SLAWSON

The study of variation of hardness in the diamond in relation to the crystal structure has been extended to the shaping and use of industrial stones. The shaping of stones for diamond-set tools, as developed through experience, reveals that the hardest directions, or "ribs," are utilized. In the case of wire-drawing dies, present knowledge of the variation of hardness and of the structure of the diamond is not sufficiently drawn upon. Suggestions are made for the improvement of the drilling and shaping processes and for the better orientation of the stones which should tend to increase the usefulness of the dies. These suggestions involve a more scientific utilization of the hardness and structural properties of the diamond, that is, of its "structural strength."

THE MOON AS A SOURCE OF TEKTITES*

H. H. NININGER

Assuming that the lunar "craters" are of meteoritic origin, this paper suggests that tektites have had their origin in connection with the impacts which formed those craters.

Note is taken of the fact that meteorites would encounter the surface of the moon at their full interplanetary velocities. The absence of a lunar atmosphere would allow ejectamenta to leave their points of origin at velocities above the minimum velocity of escape from the satellite whose gravitational power is only one-sixth that of the earth. Some of the fragments so ejected reach the earth as tektites.

Possibly some of the recognized varieties of meteorites also have this origin.

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* Presented through the Geological Society of America.

THE UNIT CELL AND SPACE GROUP OF GILLESPITE

A. PABST

Gillespite, $FeO \cdot BaO \cdot 4SiO_2$, has been found in only two localities, in an erratic boulder in Alaska and in Mariposa County, California, with sanbornite, $BaO \cdot 2SiO_2$, and barium feldspar. Gillespite from both localities was examined by x-ray powder and single crystal methods. Identical patterns are obtainable from material of both sources.

The cell dimensions are: a_0 7.50 ± 0.01 Å and $c_0 = 16.05 \pm 0.01$ Å. If the cell content is $4\mathrm{FeBaSi_4O_{10}}$, this corresponds to a density of 3.405, slightly higher than the directly determined value, 3.33.

Laue patterns confirm the tetragonal character reported by Schaller and indicate the Laue symmetry $D_{4h}-4/mmm$. All patterns show $hk0$ with $h+k$ even only, hhl and $h0l$ with l even only. This indicates the space group $D_{4h}^{8}-P4/ncc$.

Consideration of $hk0$ "reflections" shows that Fe and Ba are located on the 4 and $\bar{4}$ axes. Extreme weakness of odd layer lines on c-axis rotation patterns indicates a pseudo-cell having half the height of the true cell. Tetragonal $\mathrm{Si_4O_{10}}$ sheets parallel to (001) are the characteristic features of the structure. These sheets differ somewhat from any hitherto described but it is not yet possible to assign atomic positions with certainty.

As reported by Schaller, gillespite may be leached by hydrochloric acid with removal of iron and barium. There remain soft, pearly, flakes of hydrated silica retaining the shape and cleavage of the original particles. They remain uniaxial negative, but have much lower indices of refraction and the density is reduced to 2.0 or less, Laue, rotation and powder photographs of this material fail to show any diffraction effects.

THE IGNEOUS AND METAMORPHIC ROCKS OF THE RUMNEY QUADRANGLE, NEW HAMPSHIRE

LINCOLN R. PAGE

The igneous rocks of the Rumney quadrangle, located in west-central New Hampshire, belong to three magma series. The concordant Owls Head-Baker Pond complex, a member of the Oliverian magma series, apparently differentiated in situ. Regional deformation, probably late Devonian in age, granulated and crushed these rocks and developed an obscure secondary foliation across the primary igneous structure. The Bethlehem granodiorite gneiss and probably the Kinsman quartz monzonite, members of the New Hampshire magma series, were intruded during the late stages of this deformation. The youngest member of this series, the Concord granite, was emplaced by stoping and is clearly post-tectonic. The Three Ponds gabbro distorts the surrounding granodiorite gneiss suggesting that it made its chamber by distension of its walls rather than by the process of cauldron subsidence which is characteristic of other igneous masses of the White Mountain magma series. Pegmatite, aplite, and late lamprophyre and quartz porphyry dikes cut the older plutons and enclosing schists.

Two grades of metamorphic rocks are recognized in the area. Intermediate grade schists of the Ammonoosuc volcanics (Ordovician), Clough conglomerate and Fitch formation (Silurian) and Littleton formation (Devonian) crop out in the northwest part of the area. High grade sillimanite-mica and quartz-mica schists of the Littleton formation are typical of the central and eastern parts. At the contact of the Bethlehem granodiorite gneiss, garnet-diopside contact rock has developed in the Fitch formation. Retrograde metamorphism of the sillimanite schists was noted adjacent to the Concord granite.

JOSEITE FROM BRITISH COLUMBIA

M. A. PEACOCK

Clean fragments (sp. gr. 8.10 ± 0.05) from several specimens of a mineral resembling tetradymite, from Glacier Gulch, Hudson Bay Mountain, near Smithers, B. C., give identical x-ray powder spectra. The pattern is identical with that given by joseite (sp. gr. 8.03) from San José, Minas Geraes, Brazil (type from the collection of A. Damour), "grünlingite" (sp. gr. 8.15) from Carrock Fells, Cumberland (type locality), and "oruetite" (sp. gr. 8.11) from Serranía de Ronda, Malaga, Spain (type locality). The pattern is different from those given by tetradymite—Bi_2Te_2S and tellurbismuth—Bi_2Te_3. Since the specimen from Brazil represents the material originally described by Damour (1845) and named joseite by Kenngott (1853), the materials from British Columbia, Cumberland and Spain are referred to this species.

Single crystal x-ray photographs on the Canadian material give a rhombohedral lattice:

$$a_{rh}\ 13.45,\ \alpha\ 18°08' \text{ (from } a_0\ 4.24 \pm 0.01,\ c_0\ 39.69 \pm 0.06)$$

with no systematic omission of rhombohedral indices. With these elements the powder spectrum has been completely indexed. The existing relevant chemical analyses vary widely. The ideal content of the unit cell is probably $Bi_4(Te, S)_3$, which includes the composition Bi_4TeS_2 recently given by Warren and Davis for a mineral from Glacier Gulch resembling joseite.

IGNEOUS ROCKS OF THE COPPLE CROWN-MERRYMEETING LAKE AREA OF NEW HAMPSHIRE

ALONZO QUINN

The Copple Crown-Merrymeeting Lake area, like several other small areas in central New Hampshire, has considerable variety of rocks grouped together. Rock types here include, from oldest to youngest, felsite, diorite-gabbro, diorite, granite, quartz porphyry, and several dike rocks. Petrographically, they are related to the rocks of the White Mountain magma series of possible Carboniferous age. The variety of rock types indicates considerable differentiation of this magma.

The felsite may be extrusive, but the other rocks are intrusive. The intrusions cut sharply across the foliation and the contacts of the older rocks and are mainly in round or oval bodies. These relationships indicate a method of intrusion similar to that in nearby areas where ring-dikes and plug-like intrusions were formed.

THE GNOMONIC PROJECTION IN THE HEXAGONAL SYSTEM

LEWIS S. RAMSDELL

The implications of the G_1 and G_2 settings, used for gnomonic projections of hexagonal crystals, are made clear by constructing the unit cells from which the two projections are derived. This construction is carried out by means of the reciprocal lattice. It is shown that the G_1 setting is based on the simple structural cell, with the correct axial ratio c, whereas the G_2 setting is based on a triple cell, with an axial ratio $c_2 = c/\sqrt{3}$. This is contrary to the usage of Goldschmidt in his Kristallformen der Mineralien. The G_2 setting is commonly used for rhombohedral crystals, but the triple cell on which it is based has no direct relationship to the actual rhombohedral cell.

LAMPROBOLITE, A NEW NAME FOR BASALTIC HORNBLENDE

AUSTIN F. ROGERS

The amphibole with subadamantine luster, high indices of refraction, strong to extreme birefringence, marked pleochroism, small extinction angle, and high ferric iron content has been regarded as a distinctive mineral under the names basaltic hornblende and oxyhornblende.

The former name is objectionable since it is a double name and since it is found in many types of extrusive rocks other than basalts.

Both names are objectionable in that they imply that the mineral in question is a variety of hornblende, but I would define hornblende so as to exclude basaltic hornblende and then "hornblende" may replace "common hornblende."

For the reasons stated, I propose the name *lamprobolite* (lamp-ro-bol′it) from the

Greek, *lampros*, shining or lustrous, and *bolis*, a missile, for this mineral. The new name seems to be an appropriate one since the best specimens available are the black (deep brown on thin edges), euhedral to subhedral crystals with brilliant cleavage surfaces from the basaltic tuffs (volcanic ejectamenta) of Lukow, Bohemia.

NEPHRITE JADE FROM MONTEREY COUNTY, CALIFORNIA*

AUSTIN F. ROGERS

Nephrite jade of fair quality suitable for cutting and polishing has recently been discovered in Monterey County, California.

The color of the nephrite varies from light greenish gray to black; the best material is dark American green (Ridgway). It is identified as nephrite by optical tests, specific gravity, and a quantitative chemical analysis. The nephrite occurs in rolled pebbles and boulders of various sizes with a weight range from less than a gram up to a maximum of about 55 kg.

It is also found in place in serpentine in a region of typical Franciscan rocks.

The locality is along the Coast in the southern part of Monterey County, somewhere between Point Sur and the Salmon Creek Ranger Station and in the extreme western part of the Santa Lucia Range.

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* Presented through the Geological Society of America.

PETROLOGY OF THE PAWTUCKAWAY MOUNTAINS, NEW HAMPSHIRE*

CHALMER J. ROY AND JACOB FREEDMAN

The Pawtuckaway Mountains are located in Deerfield and Nottingham townships, Rockingham County, in southeastern New Hampshire. Rocks belonging to the White Mountain magma series, which is Mississippian in age, were intruded into the Winnepesaukee gneiss of the New Hampshire magma series, which is late Devonian in age. The intrusion formed as a circular mass of gabbro, diabase and diorite, which forced its way into the gneiss and bent foliation planes in the gneiss from the regional, northeast trend into partial parallelism with the igneous body. A foliation in the diabase and in one phase of the diorite body strikes parallel to the contact and dips inward. Injected into the more mafic rocks are bodies of fine-grained monzonite, of which the two largest bodies form a broken circle open to the southwest. A coarse-grained monzonite was later injected as the core of this arc, and a similar arc of coarse-grained monzonite surrounds the gabbro-diorite body on three sides and is also open to the southwest.

The Pawtuckaway Mountain rocks all formed from one parent magma which differentiated at depth. A porphyritic gabbro solidified against the gneiss walls as intruded magma differentiated in place into four types of diorite. The biotite, hornblende, pyroxene, and feldspar in the monzonites differ only slightly from those in the diorites.

Aplitic, monzonitic, and lamprophyric dikes cut all the major rock types. The aplitic dikes cut the lamprophyric dikes, but the relationship of monzonitic dikes to the other dikes is unknown.

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* Presented through the Geological Society of America.

OLIVINE AND PYROXENE OF MT. TRIPYRAMID, NEW HAMPSHIRE*

ALTHEA PAGE SMITH

Olivine gabbro on Mt. Tripyramid provides one field test for Bowen and Schairer's experimental findings on incongruent relations in the system MgO-FeO-SiO_2. The gabbro belongs to the post-lower Devonian White Mountain magma series of alkaline affinities. In the gabbro, the FeO/MgO ratio of olivine (58/42) and pyroxene (44/56) $CaMgSi_2O_6$-54%, $CaFeSi_2O_6$-27%, $MgSiO_3$-12%, $FeSiO_3$-7% is so high that no incongruent reaction by pyroxene on olivine would be expected. Inclusion of smooth, euhedral olivine grains in pyroxene confirms the postulate and indicates that crystallization proceeded with equilibrium. The expected absence of the silica enrichment which in other rocks is produced by incongruent reaction and fractional crystallization, is verified by the low quartz content of the intermediate rocks of the series.

Because of the crystallization with equilibrium, the olivine has a higher FeO/MgO ratio than the pyroxene, rather than either the lower ratio of many reaction-embayed olivines from other regions, or the equal ratio assumed in calculation of the norm.

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* Presented through the Geological Society of America.

PERTHITE FROM CENTRAL NEW HAMPSHIRE*

ALTHEA PAGE SMITH

In the Mt. Chocorua area the post-lower Devonian intrusions of the White Mountain magma series contain four types of perthite. In type 1 albite-oligoclase is irregularly intergrown with alkali feldspar. Neither mineral follows planes of weakness in the other. One subtype forms borders on sodic oligoclase, the latter merging through increasingly sodic zones with the similarly oriented albite-oligoclase of the intergrowth. The latter is complex, containing patches of microperthite of type 2 within much of its homogeneous orthoclase. Proportions of albite-oligoclase and alkali feldspar vary. The latter continued crystallizing after completion of the intergrowth. Perthite of type 1 is believed to be of simultaneous, but not eutectic, crystallization.

Microperthite of type 2 forms borders on, and patches within feldspar intergrowth of type 1. Type 2 consists of albite in narrow, even-spaced, parallel plane lamellae in orthoclase. The regularity of intergrowth suggests exsolution.

In type 3, microperthite of type 2 contains albite dikelets which follow and widen planes of exsolution and, rarely, planes of cleavage. Part of this albite occupied open spaces and part replaced orthoclase.

In perthite of type 4, microcline is partially replaced by irregular blebs of albite. Rare euhedral grains of the latter suggest that this perthitization occurred as early as the deuteric, or interstitial, stage.

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* Presented through the Geological Society of America.

THE SPINEL GROUP

A. N. WINCHELL

Graphs have been prepared showing the variations in composition and physical properties in some parts of the spinel group, so far as possible with available data. This leads to the conclusion that there are at least two parts of the group between which there is not continuous gradation in composition so far as now known.

OPTICAL PROPERTIES OF CLEAVAGE FLAKES

E. D. TAYLOR

The optical properties of cleavage flakes are good determinative characters. The *orientation of the cleavage plane* is a constant, and can be easily determined on inspection in convergent light. Obliquities of optical directions to the plane of cleavage can be measured by means of a calibrated eye-piece micrometer. Measuring the retardation Δ of a plate (Berek compensator) and determining its thickness (calibrated focusing motion of the microscope) are simple operations. The *birefringence of the cleavage*, $n'-n''=\Delta/t$, is thus easily obtained, with an error of only one, or less, in the third decimal place. The *refractive indices of the cleavage*, n' and n'', can be measured, by the usual immersion method, without any rolling of grains. Pleochroic colors displayed by a cleavage plate are most easily ascertained.

Although the study of cleavage flakes has long been used, especially by French mineralogists, as a check in mineral identification, only one attempt was made (by Buttgenbach) to systematize the presentation of data relative to cleavage (for about 100 minerals). New determinative tables, based on optical properties of cleavages, for all cleavable rock-forming minerals (about 200), are presented in the hope that they may be useful to supplement current identification methods. In addition, stereographic projections, on the plane of the cleavage considered, are presented in all cases (about 100) where the normal to the cleavage is inclined more than 5° to any principal optical direction.

HYDROTHERMAL DEPOSITS IN THE SPECIMEN MOUNTAIN VOLCANICS, COLORADO

ERNEST E. WAHLSTROM

Thrust fault zones in the Specimen Mountain volcanics have provided channelways along which post-volcanic hydrothermal solutions moved. Deposition in the faults and replacement of adjacent favorable layers in pyroclastics and flows has produced extensive deposits of jasper and common opal. Associated with the deposits are numerous geodes containing onyx, agate, and platy calcite.

The mineralizing solutions probably came from depth and are related to the magma which was the source of the Specimen Mountain volcanics. However, considerable time elapsed between the extrusion of the volcanics and the deposition from solutions.

THE CHROME-MICAS

D. R. E. WHITMORE

The literature of the chrome-micas is reviewed. Methods of separation of pure chrome-mica are outlined, and a new analysis of fuchsite from Pointe du Bois, Manitoba, is presented with eleven analyses compiled from the literature, from widely separated localities. The analyses are discussed from a structural point of view after the manner of Stevens, and the relationship of fuchsite to mariposite, and mariposite to alurgite is examined.

Results of an investigation of the paragenetical relationships of chrome-mica are set forth. A review of the literature and study of thin and polished sections suggest a close genetic relationship of chrome-mica to ferruginous carbonate, and also to gold in gold bearing quartz veins. Spectroscopic study suggests that traces of chromium are present in the vein minerals of the Hollinger mine.

New optical data on both mariposite and fuchsite specimens are presented.

UNIT CELL OF DICKINSONITE

C. W. WOLFE

A Weissenberg study has been made of analyzed dickinsonite from Poland, Maine. Rotation, 0-layer-line, and 1-layer-line pictures were about [010], and rotation and 0-layer-line pictures were taken about [001]. The results obtained are: $a_0 = 16.70$ Å, $b_0 = 9.95$ Å, $c_0 = 24.69$ Å, $\beta = 104°41'$; $a_0 : b_0 : c_0 = 1.695 : 1 : 2.507$; space group is $C_{2h}^6 - C_{2/c}$. Probable contents of unit cell: $4[H_2Na_6Mn_{14}(PO_4)_{12} \cdot H_2O]$. Calculated specific gravity = 3.438. Measured specific gravity: Poland—3.38, Branchville—3.41.

On two Poland crystals the following forms were found in good position as referred to the structural lattice: $c\{001\}$, $m\{110\}$, $d\{102\}$, $t\{302\}$, $j\{401\}$, $D\{\bar{1}02\}$, $E\{\bar{3}04\}$, $F\{\bar{1}01\}$, $H\{\bar{2}01\}$, $P\{\bar{1}11\}$. The structural elements do not correspond with those of Brush and Dana, derived from Branchville material. The transformation formula, Brush and Dana to structure, is: $\bar{1}00/010/102$. This is but approximate, since Brush and Dana considered their morphological studies to be inadequate. That the Poland dickinsonite is the same as the Branchville material is indicated by the analyses and by identical powder pictures obtained in this study.

Among those who were present at the scientific sessions were:

Alexander, W. H., Jr.
Ames, John
Anderson, G. H.
Argabrite, W. G.

Barnes, V. E.
Barnes, Mrs. V. E.
Bissell, H. J.
Blank, H. R.
Bruce, E. L.
Brundidge, B. D.
Buddington, A. F

Cardwell, D. H.
Clabaugh, E.
Crowell, J. C.

Dalgarn, J. C.
Dalleson, Sam
Derrising, R. M.
Donnay, J. D. H.
Dowling, Helen
Dreyer, R. M.

Foshag, W. F.
Fountain, H. C.

Giles, A. W.
Glass, J. J.
Goldich, S. S.
Goodfriend, M.
Goodrich, Dale
Goodspeed, G. E.
Gwynne, C. S.

Hall, R. B.
Harrison, J. A.
Heinrich, E. W.
Holzwasser, F.
Hunt, W. F.

Ingerson, Earl

Kerr, P. F.
Kraus, E. H.

Larsen, E. S., Jr.
Lemon, E.
Lovering, T. S.
Lutz, Hal

McConnell, Duncan
Meltzes, L. H
Merritt, C. A.
Murdoch, Joseph

Needham, C. E.
Nininger, H. H.

Pabst, A.
Petermann, J. E.
Peterson, N. P.
Phillips, D. D.
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1927 Cleveland, Ohio
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1929 Washington, D.C.
1930 Toronto, Canada
1931 Tulsa, Oklahoma
1932 Cambridge, Massachusetts
1933 Chicago, Illinois
1934 Rochester, New York
1935 New York, N.Y.
1936 Cincinnati, Ohio
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1938 New York, N.Y.
1939 Minneapolis, Minnesota
1940 Austin, Texas

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Lacroix, A., Museum of Natural History, Paris, France.
Niggli, Paul, Technical High School, Zurich, Switzerland.
Slavik, Frantisek, Charles University, Prague VI, Czechoslovakia.
Spencer, L. J., 111 Albert Bridge Road, London, S.W. 11, England.
Tilley, C. E., Cambridge University, Cambridge, England.

FELLOWS AND MEMBERS

(*Indicates Fellow)

Abrahamson, H., 3517 Lexington Avenue, Dallas, Texas.
*Adams, Elliot Q., Lamp Development Laboratory, Nela Park, Cleveland, Ohio.
Adams, John W., P.O. Box 21, Golden, Colorado.
*Agar, William M., Department of Geology, Columbia University, New York, N. Y.
Agrell, S. O., Department of Geology, University of Manchester, Manchester 13, England.
*Ahlfeld, Friedrich, Casilla 873, La Paz, Bolivia, South America.
*Aldrich, Henry R., 419 West 117 Street, New York, New York.
Alexander, A. E., 665 Fifth Avenue, New York, New York.
Alf, Raymond M., Webb School, Claremont, California.
Allen, C. M., Bay House, Pembroke, Bermuda.
*Allen, Victor T., St. Louis University, St. Louis, Missouri.
*Alling, Harold L., 31 Barrington Street, Rochester, New York.
*Aminoff, Gregori, Riksmuseet, Stockholm, Sweden.
*Andersen, Olaf, P.O. Box 201, Millington, New Jersey.
*Anderson, Charles A., Department of Geology and Mineralogy, University of California, Berkeley, California.
Anderson, George H., Texas Power and Light Co., 823 Interurban Building, Dallas, Texas.
Anderson, Keith E., Department of Geology, University of Rochester, Rochester, New York.
Andreatta, Ciro, Istituto di Mineralogia & Petrografia della R. Universita, Piazza S. Donato, 1, Bologna, Italy.
Andrew, Gerald, Box 244, Khartum, Anglo-Egyptian Sudan, Africa.
Andrews, T. G., University of Alabama, University, Alabama.
Armstead, George B., Managing Editor, *The Hartford Courant*, Hartford, Connecticut.
Armstrong, L. K., 704 Peyton Building, Spokane, Washington.
Arnold, Carl, 231 Second Avenue East, Cullman, Alabama.
Arschinow, W. W., Bol. Ordinka, 32, kw. 1, Moscow, U.S.S.R.
*Ashcroft, Frederick N., 1 Egerton Gardens, South Kensington, London S.W. 3, England.
Ayers, B. K., Croton Falls, New York.
Ayres, Vincent L., Michigan College of Mines and Technology, Houghton, Michigan.

BAILEY, A. M., Director, Colorado Museum of Natural History, City Park, Denver, Colorado.
BAILEY, E. M., Andover, Maine.
*BAIN, GEORGE W., 12 Dana Street, Amherst, Massachusetts.
BALES, C. E., Ironton Firebrick Company, Ironton, Ohio.
BALKE, CLAIRE C., 1302 Washington Street, Hoboken, New Jersey.
BANDY, MARK C., Patino Mines and Enterprises, Llallagua, Bolivia.
BANK, A. C., Holden, Washington.
BANNERMAN, HAROLD M., Dartmouth College, Hanover, New Hampshire.
*BANNISTER, F. A., 34 Monahan Avenue, Purley, Surrey, England.
BARCLAY, GEORGE C., 2912 Washington Avenue, Newport News, Virginia.
BARLETT, HELEN BLAIR, A-C Spark Plug Company, Flint, Michigan.
BARRET, HARVEY P., 2021 Vail Avenue, Charlotte, North Carolina.
BARRETT, RICHARD L., 1502 East 118 Street, Cleveland, Ohio.
*BARTH, TOM F. W., Mineralogisk Institut, Blindern, Oslo, Norway.
*BASCOM, FLORENCE, Williamstown, Massachusetts.
*BASTIN, EDSON S., University of Chicago, Chicago, Illinois.
*BATEMAN, ALAN M., Yale University, New Haven, Connecticut.
BATH, RAY, Piney Branch Apts., Apt. 2, Bldg. 2, Silver Springs, Maryland.
*BAUER, LAWSON H., New Jersey Zinc Company, Franklin, New Jersey.
*BAYLEY, WILLIAM S., University of Illinois, Urbana, Illinois.
*BEHRE, CHARLES H. JR., Department of Geology, Northwestern University, Evanston, Illinois.
BELL, GORDON L., 485 Elwood Avenue, Oakland, California.
BELL, JAMES FORBES, Consolidated Gas and Electric Company, Research Department, Baltimore, Maryland.
BENNER, R. C., Director, Research Laboratory, Carborundum Company, Niagara Falls, New York.
BENOIT, FRANK E., 802 Christopher Street, Austin, Texas.
BERESFORD, W. E., 328 Marietta Street, N.W., Atlanta, Georgia.
*BERMAN, HARRY, 12 Geological Museum, Harvard University, Cambridge, Massachusetts.
BERNHEIMER, ALAN W., 2259 North Park Avenue, Philadelphia, Pennsylvania.
BERRY, LEONARD G., 89 Dewson Street, Toronto, Ontario, Canada.
BETEKHTIN, A. G., Chkalovskaja Ul. 21, kv. 38, Moscow 64, U.S.S.R.
BETZ, FREDERICK, JR., Department of Geology, Princeton University, Princeton, New Jersey.
*BILLINGS, MARLAND P., Harvard University, Cambridge, Massachusetts.
BIREN, HELEN A., Brooklyn College, Bedford Avenue and Avenue H., Brooklyn, New York.
BJAREBY, GUNNAR, 147 Worthington Street, Boston, Massachusetts.
BLANK, HORACE R., Soil Conservation Service, Box 26, Waco, Texas.
BLASKO, CHARLES, 902 6th Street, Rock Springs, Wyoming.
BLONDEL, FERNAND, 13 Rue de Bourgogne, Paris VIII, France.
BOATNER, H., 420 Woodruff Building, Springfield, Missouri.
BOGUE, RICHARD G., 399 Rutherford Avenue, Franklin, New Jersey.
BOUBEE, NEREE, 3 Boulevard et Place St. Andre-des-Arts, Paris, France.
*BOWEN, NORMAN L., University of Chicago, Chicago, Illinois.
*BOWLES, OLIVER, U. S. Bureau of Mines, Washington, D.C.
BOWLEY, H., Government Chemical Laboratory, Wellington Street, Perth, Western Australia.

Bradley, W. F., Illinois State Geological Survey, Urbana, Illinois.
*Bramlette, Milton N., Department of Geology, University of California at Los Angeles, California.
Brant, Arthur M., Lord Hall, Ohio State University, Columbus, Ohio.
Bray, Joseph M., Department of Geology, Lafayette College, Easton, Pennsylvania.
Brown, W. R., 19 Frazier Street, Staunton, Virginia.
*Bruce, E. L., Department of Mineralogy, Queen's University, Kingston, Ontario, Canada.
Bryant, W. M. D., R.F.D. 3, Silverside Road, Wilmington, Delaware.
Buckelew, Harold C., 1048 Broad Street, Newark, New Jersey.
*Buddington, Arthur F., Princeton University, Princeton, New Jersey.
*Buerger, Martin J., Massachusetts Institute of Technology, Cambridge, Massachusetts.
*Buerger, Newton W., Department of Mineralogy, Queen's University, Kingston, Ontario, Canada.
Buie, Bennett F., c/o D. F. Buie, Patrick, South Carolina.
Bullard, Fred M., 903 West 30 Street, Austin, Texas.
Bunton, Paul B., 5 Plaza Way, S.W., Atlanta, Georgia.
*Burbank, Wilbur S., U. S. Geological Survey, Washington, D. C.
Burfoot, James D. Jr., Department of Geology, Cornell University, Ithaca, New York.
Burrows, Percy W., 121 Oakland Street, Mansfield, Massachusetts.
*Butler, G. Montague, University of Arizona, Tucson, Arizona.
Butler, John W. Jr., Apartado Aereo 3577, Bogota, Colombia.
*Butler, Robert D., London Mines and Milling Company, Alma, Colorado.
*Buttgenbach, Henry J., 7 Avenue Emile Digneffe, Liege, Belgium.

*Callaghan, Eugene, U. S. Geological Survey, Washington, D.C.
Callahan, William H., Franklin, New Jersey.
Cameron, Eugene N., Department of Geology, Columbia University, New York, New York
Campbell, Charles D., Box 21, Washington State College, Pullman, Washington.
*Campbell, Ian, California Institute of Technology, Pasadena, California.
Caplan, Allan, Hotel Willard, New York, New York.
Capps, Mrs. Washington L., 1823 Jefferson Place, N.W., Washington, D.C.
Carhart, Grace M., Hunter College, Bedford Park Boulevard and Navy Avenue, New York, New York.
*Carobbi, Guido, Direttore del Istituto di Mineralogia della R. U., Florence, Italy.
Chace, Frederick M., 656 South Oak Knoll Avenue, Pasadena, California.
Chapman, Carleton A., Department of Geology, University of Illinois, Urbana, Illinois
Chapman, Ernest W., 1934 Mill Road, South Pasadena, California.
Chapman, Randolph, Department of Geology, Johns Hopkins University, Baltimore, Maryland.
Chesley, Frank G., Massachusetts Institute of Technology, Cambridge, Massachusetts.
Chesterman, Wesley C., 810 Hyde Street, San Francisco, California.
Childs, Edward C., Norfolk, Connecticut.
Chute, Newton E., Department of Geology, University of Missouri, Columbia, Missouri.
Cistar, Louis A., 129 Avenue B, Rochester, New York.
Coats, Robert, Alaskan Branch, Geological Survey, Washington, D.C.

Coetzee, C. B., Department of Geology, University of Cape Town, Rondebosch, Cape Town, South Africa.
*Colburn, Burnham S., Greystone Court, Biltmore, North Carolina.
Colburn, William B., 333 Washington Road, Grosse Pointe, Michigan.
*Connolly, Joseph P., 1804 W. Boulevard, Rapid City, South Dakota.
*Cooke, S. R. B., Montana School of Mines, Butte, Montana.
Cooley, Mary E., 703 South Forest Avenue, Ann Arbor, Michigan.
Cooper, John R., Ohio Wesleyan University, Delaware, Ohio.
*Corbett, Clifton S., 17th Floor, 26 Broadway, New York, New York.
Courtright, Hugh C., 4940 East End Avenue, Chicago, Illinois.
Crawford, Arthur L., 1067 East Fifth Street South, Salt Lake City, Utah.
*Crawford, R. D., 1050 Tenth Street, Boulder, Colorado.
Crickmay, Geoffrey W., Box 549, Athens, Georgia.
Crippen, Richard A., 255 North Linden, Bloomington, California.
Crump, R. M., Bureau of Mines, Min. Dist. 5, Surigao, Surigao, Philippine Islands.
Crunden, A. B., 54 Edgemont Road, Montclair, New Jersey.
Cummins, A. B., Valley Road, Millington, New Jersey.
Currie, James C., Rawhide, Nevada.
*Currier, Louis W., U. S. Geological Survey, Washington, D.C.
Cuthbert, F. Leicester, Natural Resources Building, University of Illinois, Urbana, Illinois.

Dake, H. C., *The Mineralogist*, 703 Couch Building, Portland, Oregon.
Davidson, Stanley C., 52 Wembley Drive, Sudbury, Ontario, Canada.
Davis, Donald W., Scarsdale Manor, Apt. R-North, Scarsdale, New York.
Davis, Harry T., Curator of Geology, North Carolina State Museum, Raleigh, North Carolina.
Dennis, William Engs, Jr., Box 373, Newport, Rhode Island.
Denny, M. V., Mineralogical Laboratory, University of Michigan, Ann Arbor, Michigan.
Dickey, Z. M., P.O. Box 306, Dinuba, California.
*Dodge, Francis D., 69 Avenue "A," Bayonne, New Jersey.
Dodge, Theodore A., 766 Pacific Electric Building, Los Angeles, California.
*Donnay, Joseph D. H., Université Laval, Boulevard de l'Entente, Quebec, Canada.
Doten, Robert K., Basin Farm, Brandon, Vermont.
Doyle, C. C., Plaza Venustiano Carranza 45, Zacatecas, Zacatecas, Mexico.
Draeger, R. H., Medical Corps, U.S.N., Marine Detachment, Tientsin, China.
Draisin, Wilbur M., Department of Mineralogy, Harvard University, Cambridge, Massachusetts.
Dreyer, Robert M., Department of Geology, University of Kansas, Lawrence, Kansas.

*Eckel, Edwin B., U. S. Geological Survey, Washington, D.C.
Edmundson, R. S., Virginia Geological Survey, Box 1428, University Station, Charlottesville, Virginia.
Eggleston, Julius W., Junior College, Riverside, California.
Ehrmann, Martin L., 630 Fifth Avenue, New York, New York.
Eliseev, N. A., Naberezhnaja Zhoresa 26, kv. 14, Leningrad 194, U.S.S.R.
*Ellsworth, H. V., Canada Geological Survey, Ottawa, Canada.
Elwell, Wilbur J., 2 Duck Street, Danbury, Connecticut.
Emery, Alden H., American Chemical Society, Mills Building, Washington, D.C.
*Emmons, Richard C., University of Wisconsin, Madison, Wisconsin.

Engel, Rene, Marsman & Co., Box 297, Manila, Philippine Islands.
*English, George L., 50 Brighton Street, Rochester, New York.
Evers, John R., 19 South Broadway, Tarrytown, New York.

Faessler, Carl, Université Laval, Boulevard de l'Entente, Quebec, Canada.
Fahey, J. J., U. S. Geological Survey, Washington, D.C.
*Fairbairn, Harold W., Department of Geology, Massachusetts Institute of Technology, Cambridge, Massachusetts.
*Fairchild, John G., U. S. Geological Survey, Washington, D.C.
*Faust, George T., Sunnyside Road, Berwyn, Maryland.
*Fenner, Clarence N., 64 Broad Street, Clifton, New Jersey.
*Fettke, Charles R., 1118 Wightman Street, Squirrel Hill Station, Pittsburgh, Pennsylvania.
*Fisher, D. Jerome, University of Chicago, Chicago, Illinois.
*Fisher, Lloyd W., Department of Geology, Bates College, Lewiston, Maine.
Fisk, Henry G., 2261 West 120 Street, Blue Island, Illinois.
Flack, Wylie H., 609 Maple Avenue, La Porte, Indiana.
Fleener, F. L., Joliet Township High School and Junior College, Joliet, Illinois.
Fleischer, Arthur, 81 Navajo Street, Salt Lake City, Utah.
*Fleischer, Michael, U. S. Geological Survey, Washington, D.C.
Folinsbee, Robert E., Department of Geology, University of Minnesota, Minneapolis, Minnesota.
Foote, Freeman, Department of Geology, Williams College, Williamstown, Massachusetts.
Ford, Hugh Alexander, British Consulate General, Room 724, 10 Post Office Square, Boston, Massachusetts.
*Foshag, William F., U. S. National Museum, Washington, D.C.
Foster, Philip C., 497 Huntington Avenue, Apt. 35, Boston, Massachusetts.
Foster, Wilder D., 4800 Forbes Street, Pittsburgh, Pennsylvania.
Foster, Wilfrid R., Department of Geology, Catholic University of America, Washington, D.C.
*Fraser, Donald M., Department of Geology, Lehigh University, Bethlehem, Pennsylvania.
Fraser, Horace J., Department of Geology, California Institute of Technology, Pasadena, California.
Fraser, R. J., Jr., 3020 Andrita Street, Los Angeles, California.
Fretz, A. Henry, 42 West Market Street, Bethlehem, Pennsylvania.
Fritts, Herbert L., 628 Helen Avenue, Detroit, Michigan.
*Frondel, Clifford, 12 Geological Museum, Harvard University, Oxford Street, Cambridge, Massachusetts.
Fuller, Richard E., 1642 Federal Avenue, Seattle, Washington.
Funk, B. Gordon, 22 East Valerio Street, Santa Barbara, California.
Fye, E. G. Jr., General Delivery, Denver, Colorado.

Gabriel, Alton, U. S. Bureau of Mines, College Park, Maryland.
*Gage, R. B., Box 199, Trenton, New Jersey.
Galbraith, F. W., Department of Geology, University of Arizona, Tucson, Arizona.
Gallagher, David, 349 Clark Road, Brookline, Massachusetts.
Gardner, Dion L., Marsman and Company, Paracale, Camarinas Norte, Philippine Islands.

Garrido, Julio, Lagasca 125, Madrid, Spain.
Gates, Robert M., 410 South Orchard Street, Madison, Wisconsin.
Gault, H. Richard, Department of Geology, Johns Hopkins University, Baltimore, Maryland.
Geisse, Harold L., 1002 Fulton Street, Wausau, Wisconsin.
Gerson, Fred, 5421 Cornell Street, Hyde Park Station, Chicago, Illinois.
Gianella, Vincent P., Mackay School of Mines, Reno, Nevada.
Gillespie, T. B., Palatka, Florida.
Gillingham, Thomas E., Department of Geology, University of Minnesota, Minneapolis, Minnesota.
*Gillson, Joseph L., 8060 DuPont Building, Wilmington, Delaware.
*Gilluly, James, Department of Geology, University of California at Los Angeles, California.
Ginsberg, A. S., Pesotschnaia 4, kv. 35, Leningrad, U.S.S.R.
*Glass, Jewell J., U. S. Geological Survey, Washington, D.C.
Goddard, Archibald N., 630 Virginia Park, Detroit, Michigan.
Goddard, E. N., U. S. Geological Survey, Washington, D.C.
Goldich, Samuel S., A. & M. College of Texas, College Station, Texas.
Goldring, Ewart D., Saratoga, Wyoming.
Gomez, Gabriel E., Director del Departmento de Petroleos, Ministerio de la Economia Nacional, Bogota, Colombia.
*Goodspeed, George E., University of Washington, Seattle, Washington.
Gordon, D. M., 203 Tennessee Avenue, N.E., Washington, D.C.
*Gordon, Samuel G., Philadelphia Academy of Natural Sciences, Logan Circle, Philadelphia, Pennsylvania.
*Gordon, William T., Kings College, Strand, London, W.C. 2, England.
Goudey, Hatfield, Harvard Mine, Jamestown, California.
Graber, B. P., Barrington, Illinois.
*Graham, R. P. D., McGill University, Montreal, Canada.
Grahl, Harry, 885 Cauldwell Avenue, Bronx, New York.
*Graton, Louis C., Rotch Building, Cambridge, Massachusetts.
Grawe, Oliver R., Missouri School of Mines, Rolla, Missouri.
Gray, Herbert, 400 Irving Avenue, Brooklyn, New York.
*Greig, Joseph W., Geophysical Laboratory, Washington, D.C.
Grieger, J. M., 405 Ninita Parkway, Pasadena, California.
Grill, E., Direttore dell Ist. di Mineralogia, Citta degli Studi-Via Botticelli 67, Milan, Italy.
*Grim, Ralph E., Illinois Geological Survey, Urbana, Illinois.
*Grout, Frank F., University of Minnesota, Minneapolis, Minnesota.
*Gruner, John W., University of Minnesota, Minneapolis, Minnesota.
Grutt, Eugene, Jr., 329 West 4th Street, Reno, Nevada.
Gummer, Wilfrid K., Department of Geology, University of Chicago, Chicago, Illinois.
Gysin, M. E., Laboratoire de Mineralogie de l’Universite, Quai de l’Ecole-de-Medecin Geneva, Switzerland.

Haff, John C., Colorado School of Mines, Golden, Colorado.
Hagner, Arthur F., Department of Geology, University of Wyoming, Laramie, Wyoming.
Halbouty, M. T., Merit Oil Corporation of Texas, Shell Building, Houston, Texas.
Hale, Charles H., Edgewood Arsenal, Edgewood, Maryland.
Hall, F. P., 206 Granger Road, R.F.D. 4, Syracuse, New York.

*Hall, George M., University of Tennessee, Knoxville, Tennessee.
Hanley, Franklin B., Department of Geology, University of Minnesota, Minneapolis, Minnesota.
Hanley, John B., 323 Main Street, Lewiston, Maine.
Harcourt, G. A., Copper Cliff, Ontario, Canada.
Hartley, B. W., Haileybury, Ontario, Canada.
Harumoto, Atsuo, c/o Meiji-Kogyo-Kaisha, Tobata-shi, Fukuoka-Kan, Japan.
Hatch, Robert B., Mineralogical Laboratory, University of Michigan, Ann Arbor, Michigan.
*Hawkins, A. C., P.O. Box 645, Winchester, Virginia.
*Hawley, James E., Queen's University, Kingston, Ontario, Canada.
Heineman, Robert E. S., El Encanto Estates, Tucson, Arizona.
*Henderson, Edward P., U. S. National Museum, Washington, D.C.
*Hendricks, Sterling B., 3045 Albemarle Street, N.W., Washington, D.C.
Herlinger, D. Erich, P.O. Box 26, Rehovoth, Palestine.
*Hess, Frank L., 1221 Newton Street, N.E., Washington, D.C.
*Hess, Harry H., Princeton University, Princeton, New Jersey.
*Hewett, Donnel F., U. S. Geological Survey, Washington, D.C.
Heyl, Allen V., Jr., R.F.D. 2, Allentown, Pennsylvania.
Heyl, George R., Arkansas Geological Survey, Little Rock, Arkansas.
Hickok, William O., IV, R.F.D. 3, Linglestown, Pennsylvania.
Hill, H. Stanton, Geology Department, Pasadena Junior College, Pasadena, California.
Hill, V. D., Route 7, Box 302, Salem, Oregon.
Hills, Ralph F., 35 Manchester, Hartford, Connecticut.
Hills, Thomas M., Department of Geology, Vassar College, Poughkeepsie, New York
Himmel, Hans, Mineralogical Laboratory, Hauptstrasse 48, Heidelberg, Germany.
Hirschi, Hans, Erlen (Thurgan), Switzerland.
*Hodge, Edwin T., 2915 Luray Terrace, N.W., Portland, Oregon.
*Holden, Guerdon S., Plain Dealer Building, Cleveland, Ohio.
*Holmes, Arthur, Science Laboratory, South Road, Durham, England.
Holmes, Ralph J., Department of Geology, Columbia University, New York, New York
*Honess, Arthur P., 505 East Prospect Avenue, State College, Pennsylvania.
Hooker, Marjorie, 32-14 146 Street, Flushing, New York.
Horn, Aubrey E., Naraguta Tin Mines, Ltd., P.O. Jos, Plateau Province, Northern Nigeria, West Africa.
Hose, Heath Roydon, c/o J. L. Mutter, Canadian Government Trade Commissioner, 2nd floor, Union Building, Singapore.
Howland, Arthur L., Northwestern University, Evanston, Illinois.
Hughes, Paul, P.O. Box 121, Azusa, California.
Hugill, William, Langham House, Fields Road, Alsager, Cheshire, England.
*Hunt, Walter F., Mineralogical Laboratory, University of Michigan, Ann Arbor, Michigan.
*Hurlbut, Cornelius, Jr., Harvard University, Cambridge, Massachusetts.
Hurlbut, P. K., Jr., 701 North Pearl Street, Joplin, Missouri.
Hurst, George D., 322 West 56 Street, New York, New York.
Hutchinson, R. M., 231-1901 Hall, Princeton, New Jersey.
Hutton, C. Osborne, 156, The Terrace, Wellington, New Zealand.

*Ingerson, Earl, Geophysical Laboratory, Washington, D.C.
*Insley, Herbert, Bureau of Standards, Washington, D.C.

Inuzuka, Hideo, No. 1174, Magome-machi, 1-chome, Omori-Ku, Tokyo, Japan.
Irwin, William H., Box 656, Chapel Hill, North Carolina.
*Ito, Teeichi, Imperial University, Hongo, Tokyo, Japan.

Jacobs, Elbridge C., University of Vermont, Burlington, Vermont.
Jarrell, O. W., Casilla 655, Guayaquil, Ecuador.
Jeffries, Charles D., 622 Holmes Street, State College, Pennsylvania.
Jensen, David E., 28 Birch Crescent, Rochester, New York.
Jensen, Nan C., 1505 North Scott Street, Arlington, Virginia.
*Johannsen, Albert, University of Chicago, Chicago, Illinois.
Johnson, J. Harlan, Box 343, Golden, Colorado.
*Johnston, R. A. A., 112 Old Forest Hill Road, Toronto 10, Ontario, Canada.
*Johnston, William D., Jr., U. S. Geological Survey, Washington, D.C.
*Jolliffe, Alfred W., Canada Geological Survey, Ottawa, Ontario, Canada.
Jones, Gardner H., Box 136, West Lebanon, New Hampshire.
Jones, R. E., New Wilmington, Pennsylvania.
Judson, Charles Esq. 12 Norham Road, Oxford, England.

Kaiser, Edward P., Franklin, New Jersey.
Karlsson, Albert, 3042 Grand Concourse, New York, New York.
Kassner, Meyer J., 628 Main Street, Laconia, New Hampshire.
Katano, Toyoo, No. 18, Kaname-cho, 2-chome, Toshima-ku, Tokyo, Japan.
Kaub, George H., 740 Steele Street, Denver, Colorado.
Keenan, John, Indian Road, Fieldstone, Riverdale, New York.
Keller, W. D., 208 Swallow Hall, Columbia, Missouri.
Keppel, David, Wesleyan University, Middletown, Connecticut.
Kernochan, Mrs. Edward L., 1926 Wood Avenue, Colorado Springs, Colorado.
*Kerr, Paul F., Columbia University, New York, New York.
Kerr-Lawson, Ferga C., Box 5, Swastika, Ontario, Canada.
Kessler, Charles N., Placer Hotel, Helena, Montana.
King, K. Van Ness, 2942 Russell Street, Berkeley, California.
*Klein, A. A., Norton Company, Worcester, Massachusetts.
Klein, Ira, Walkermine, California.
Knabe, William C., 3853 North Gratz Street, Philadelphia, Pennsylvania.
*Knopf, Adolph, Yale University, New Haven, Connecticut.
*Koschmann, A. H., U. S. Geological Survey, Washington, D.C.
*Kozu, S., Tohoku Imperial University, Sendai, Japan.
Krantz, F., Herwarthstrasse 36, Bonn, Germany.
*Kraus, Edward H., University of Michigan, Ann Arbor, Michigan.
*Krishnan, M. S., 27 Chowringhee, Calcutta, India.
Kuenstler, Walter E., 410 Lafayette Avenue, Grantwood, New Jersey.
Kurbatov, Joann D., Apt. 36, 2090 Neil Avenue, Columbus, Ohio.

Lamm, Rudolf, Leipzig C.1, Germany.
*Landes, Kenneth K., University of Kansas, Lawrence, Kansas.
*Lane, Alfred C., 22 Arlington Street, Cambridge, Massachusetts.
*Larsen, Esper S., Jr., 59 Orchard Street, Belmont, Massachusetts.
Larsen, Esper S., 3rd, 59 Orchard Street, Belmont, Massachusetts.
Larson, Alfred, 1247 Labme Avenue, Wilmington, California.
Lausen, Carl, 308 Stapleton Building, Billings, Montana.

Lee, Harley C., Department of Mineralogy, Ohio State University, Columbus, Ohio.
Lee, K. K., 211 Honan Road, Shanghai, China.
*Lee, O. Ivan, 2684 Boulevard, Jersey City, New Jersey.
Leineweber, I. A., 2718 Bainbridge Avenue, Bronx, New York.
Lemcke, W. L., 609 14th Street, Franklin, Pennsylvania.
Lemmon, Dwight M., U. S. Geological Survey, Washington, D.C.
Lewis, Frank A., U. S. Naval Medical Supply Depot, Brooklyn, New York.
Lewis, W. Scott, 2500 North Beachwood Drive, Hollywood, California.
Lima, Plinio de, Rua Vitorino Carmillo 565, Sao Paulo, Brazil.
Lohse, R. A., Box 1334, Richmond, California.
Lomerson, William W., 88 Morningside Drive, New York, New York.
Longchambon, H., Faculte des Sciences, 18 Quai Claude Bernard, Lyon, France.
Longley, W. Warren, 1069 11th Street, Boulder, Colorado.
*Lonsdale, John T., Iowa State College, Ames, Iowa.
Lopez, Victor M., Servicio Tecnico de Mineria y Geologia, Estados Unidos de Venezuela, Caracas, Venezuela.
*Louderback, George D., University of California, Berkeley, California.
*Loughlin, Gerald F., U. S. Geological Survey, Washington, D.C.
*Lovering, Thomas S., Department of Geology, University of Michigan, Ann Arbor, Michigan.
Lowe, Kurt E., 601 West 160 Street, New York, New York.
Lubashek, Alvin, 523 Livingston Hall, Columbia University, New York, New York.
Lukesh, Joseph S., Room 4-469, Massachusetts Institute of Technology, Cambridge, Massachusetts.
Lyons, Erwin J., Department of Geology, Johns Hopkins University, Baltimore, Maryland.

Macdonald, Gordon A., Geological Survey, 333 Federal Building, Honolulu, Hawaii.
MacKenzie, G. S., University of New Brunswick, Fredericton, New Brunswick, Canada.
MacMillan, Robert S., 10 Maryland Road, Grass Valley, California.
*Manchester, James G., Hampton Bays, Long Island, New York.
Manning, Marvis, Decker, Indiana.
*Marble, John P., 37 East Bradley Lane, Chevy Chase, Maryland.
*Martens, James H. C., 308 Spring Street, Morgantown, West Virginia.
Martin, E. B., Westbury, Long Island, New York.
Mastaw, Sam, 517 Johnstone Street, Sault Ste. Marie, Michigan.
Matheewn, K. K., Ul. Kuibysheva 30, Mineralogitcheski Kabinet, Gornogo Instituta, Sverdlovsk, U.S.S.R.
*Mathews, Edward B., Johns Hopkins University, Baltimore, Maryland.
Mauguin, Charles, 1, Rue Victor Cousin, Paris 5, France.
Maurice, Charles S., University of Tennessee, Knoxville, Tennessee.
Mawby, M. A., Zinc Corporation Ltd., Broken Hill, New South Wales, Australia.
*Maynard, James E., Syracuse University, Syracuse, New York.
*McCaughey, William J., Ohio State University, Columbus, Ohio.
*McConnell, Duncan, University of Texas, Austin, Texas.
McKinley, William C., 2201 North Sheridan Road, Peoria, Illinois.
*McKinstry, Hugh E., Science Hall, University of Wisconsin, Madison, Wisconsin.
*McLaughlin, Donald H., Department of Mining Geology, Harvard University, Cambridge, Massachusetts.
McLellan, Roy D., Research Department, American Smelting and Refining Co., Perth Amboy, New Jersey.

McLeod, Edith, 413 High Street, Klamath Falls, Oregon.
McNairn, W. Harvey, McMaster University, Hamilton, Ontario, Canada.
*McVay, Thomas N., University of Alabama, University, Alabama.
*Mead, Warren J., Massachusetts Institute of Technology, Cambridge, Massachusetts.
*Meen, V. Ben, Department of Mineralogy, University of Toronto, Toronto, Ontario, Canada.
Megathlin, G. R., State Normal School, Geneseo, New York.
Melish, Mrs. Thomas, 363 Lafayette Avenue, Cincinnati, Ohio.
Mencher, Ely, Instituto de Geologia, Avenida San Martin, Caracas, Venezuela.
Menninger, C. F., 3617 West 6th Avenue, Topeka, Kansas.
Merritt, C. A., University of Oklahoma, Norman, Oklahoma.
Merritt, Philip L., 1937 West Main Street, Stamford, Connecticut.
Mertie, J. B., Jr., U. S. Geological Survey, Washington, D.C.
*Merwin, Herbert E., Geophysical Laboratory, Washington, D.C.
Michener, Charles E., 284 Cedar Street, Sudbury, Ontario, Canada.
*Miller, Benjamin L., Lehigh University, Bethlehem, Pennsylvania.
Miller, Franklin S., 1029 Bryden Road, Columbus, Ohio.
Miller, Fred A., 5171 Broadway, Indianapolis, Indiana.
*Miller, William J., 691 Loring Avenue, Village Station, Los Angeles, California.
Milton, Charles, U. S. Geological Survey, Washington, D.C.
*Miser, Hugh D., U. S. Geological Survey, Washington, D.C.
Miyake, Teirumi, c/o Seishoen, Naka-Kaigan, Chigasaki-machi, Kanagawe-Ken, Japan.
Moneymaker, Berlen C., Pound Building, Tennessee Valley Authority, Chattanooga, Tennessee.
Montgomery, Arthur, 1 East 44 Street, New York, New York.
*Moore, Elwood S., University of Toronto, Toronto, Canada.
Morgan, Leonard A., 8 Lincoln Ave., Dover, New Jersey.
*Morris, Frederick K., Massachusetts Institute of Technology, Cambridge, Massachusetts.
Mortimer, George N., Shelton, Nebraska.
*Morton, James F., 268 Summer Street, Paterson, New Jersey.
Moyd, Louis, 472 South Broadway, Yonkers, New York.
Mrazck, L., Fondul Universitar, Laboratorul de Mineralogie Generale, Boulevard Bratianu No. 1, Bucharest, Roumania.
Murata, K. J., U. S. Geological Survey, Washington, D.C.
*Murdoch, Joseph, University of California at Los Angeles, California.
Murphy, Richard, 901 Federal Building, Toronto, Ontario, Canada.
Murray, Albert N., University of Tulsa, Tulsa, Oklahoma.
Myers, Richmond E., Department of Geology, Muhlenberg College, Allentown, Pennsylvania.
Myers, V. Dale, 1030 Galloway Street, Pacific Palisades, California.
*Myers, William M., School of Mineral Industries, Pennsylvania State College, State College, Pennsylvania.

Nagelschmidt, G., Rothamstead Exp. Station, Harpenden, Herts, England.
Neiman, Robert, 505 East Chestnut Street, Louisville, Kentucky.
Nelson, Gaylord, 126 Sheldon Avenue, S.E., Grand Rapids, Michigan.
Newcomet, William S., 3501 Baring Street, Philadelphia, Pennsylvania.
*Newhouse, Walter H., Massachusetts Institute of Technology, Cambridge, Massachusetts.
Newman, Leonard Lewis, Fairbanks, Alaska.

Nichols, Henry W., Field Museum of Natural History, Chicago, Illinois.
Nijhoffs, N. V. Martinus, Lange Voorhout 9, The Hague, Holland.
Niles, Glenn H., P. O. Box 1406, Paterson, New Jersey.
Nisson, William H., 15 Batchelor Terrace, Petaluma, California.
*Noble, James A., Homestake Mining Company, Lead, South Dakota.
*Nolan, Thomas B., U. S. Geological Survey, Washington, D.C.
Northup, M. Allen, Godet Place, Morristown, New Jersey.
Nutting, P. G., U. S. Geological Survey, Washington, D.C.

O'Connell, Daniel T., College of the City of New York, New York, New York.
Odman, Olaf H., Box 77, Boliden, Sweden.
Ohmori, Kei-iti, Mineralogical Institute, Tohoku Imperial University, Sendai, Japan.
O'Leary, W. J., Norton Company, Chippawa, Ontario, Canada.
Olson, J. C., U. S. Geological Survey, Washington, D.C.
*Orcel, Jean, Museum, 61 Rue de Buffon, Paris, France.
Osborn, Elburt F., Geophysical Laboratory, Washington, D.C.
Otersen, Lillian M., 16 Grove Place, Prospect Beach, West Haven, Connecticut.
Over, Edwin J., Jr., 558 19th Avenue, San Francisco, California.

*Pabst, Adolf, University of California, Berkeley, California.
Page, Lincoln R., U. S. Geological Survey, Washington, D.C.
*Palache, Charles, 106 Appleton Street, Cambridge, Massachusetts.
Palumbo, Roberto, 211, Corso Trieste, Rome, Italy.
Panichi, Ugo, Istituto di Mineralogia, della R. Universita di Pavia, Viale Tarameli, Pavia, Italy.
Park, Charles F., Jr., U. S. Geological Survey, Washington, D.C.
*Parker, Robert L., Technische Hochschule, Zurich 6, Switzerland.
Parrish, William, Pennsylvania State College, State College, Pennsylvania.
*Parsons, Arthur L., University of Toronto, Toronto, Ontario, Canada.
Parsons, Willard H., Hamilton College, Clinton, New York.
Pask, Joseph A., 204 Ceramics Building, University of Illinois, Urbana, Illinois.
*Peacock, Martin A., University of Toronto, Toronto, Ontario, Canada.
Pearce, D. W., Purdue University, Lafayette, Indiana.
Pearl, Richard M., 749 Sixteenth Street, Boulder Colorado.
*Peck, Albert B., University of Michigan, Ann Arbor, Michigan.
Pecora, William T., U. S. Geological Survey, Washington, D.C.
*Pegau, Arthur A., Rugby Road, Charlottesville, Virginia.
Penn, Charles J., 460 Avenue Road, Toronto, Ontario, Canada.
*Peoples, Joe Webb, Wesleyan University, Middletown, Connecticut.
Perier, Garfield B., 804 Diamond Street, Butte, Montana.
Perry, Elwyn L., Williams College, Williamstown, Massachusetts.
Petermann, Jean E., 243 Tamarack Street, Laurium, Michigan.
*Pettijohn, Francis J., University of Chicago, Chicago, Illinois.
Phelps, Willard B., University of Tampa, Tampa, Florida.
Phemister, T. C., University of Aberdeen, Marischal College, Aberdeen, Scotland.
Philbrick, Shailer S., 87 South Fremont Street, Pittsburgh, Pennsylvania.
Philbrook, Mrs. P. M., Box 184, Sacramento, California.
Pierce, Albert C., 606 West 19 Street, Wilmington, Delaware.
Pizarro, Carlos J., Braden Copper Company, Rancagua, Chile.
Pohl, John C., Jr., 204 North Tenth Street, Easton, Pennsylvania.

Polk, E. H., 4193 Poplar Street, Memphis, Tennessee.
Pope, G. N., 1820 Bay Street, Alameda, California.
Postel, William, Department of Geology, University of Pennsylvania, Philadelphia, Pennsylvania.
*Pough, Frederick H., American Museum of Natural History, New York, New York.
*Pratt, Joseph Hyde, Chapel Hill, North Carolina.
Prince, Alan T., 547 Roxton Road, Toronto, Ontario, Canada.
Prokes, Albert J., 1625 South 11 Street, St. Louis, Missouri.

*Quinn, Alonzo W., Brown University, Providence, Rhode Island.
*Quirke, Terence T., University of Illinois, Urbana, Illinois.

*Ramsdell, Lewis S., University of Michigan, Ann Arbor, Michigan.
Reamer, Louis, 336 Elizabeth Street, Orange, New Jersey.
*Reinhard, Max, Mineralogical Institute, University of Basel, Switzerland.
Reyes, Jorge Munoz, Apartado 267, La Paz, Bolivia.
Richmond, Wallace E., Jr., U. S. Geological Survey, Washington, D.C.
Ridge, John, 624 Aldine Street, Chicago, Illinois.
*Ries, Heinrich, 401 Thurston Avenue, Ithaca, New York.
Rinn, Harold W., 1116 West Carpenter Street, Midland, Michigan.
Rivero, Manuel, Servicio Geologico, Ministerio de Obras Publicas, Caracas, Venezuela.
Robinson, George P., 16 Simpson Street, Hartford, Connecticut.
Roedder, Edwin W., Devon, Pennsylvania.
*Rogers, Austin F., Stanford University, California.
Rollins, Ross, 69 Cypress Street, Brookline, Massachusetts.
Roper, George W., Public Market Building, 13th and J Streets, Sacramento, California.
Rosenberg, Ernesto R., Via Mezzocannone 31, Naples 70, Italy.
Rosenholtz, Joseph L., Rensselaer Polytechnic Institute, Troy, New York.
Rosenkrans, R. R., 3 North Meridian Street, Red Key, Indiana.
*Rosicky, Vojtech, Brno-Reckovice, Nazlebcich 105, Böhmen-Mähren.
*Ross, Clarence S., U. S. Geological Survey, Washington, D.C.
Rowe, Grant, 315 South Jefferson Street, Saginaw, Michigan.
Rowland, Richards A., Illinois Geological Survey, Urbana, Illinois.
Roy, Sharat K., Field Museum of Natural History, Chicago, Illinois.
Royer, Louis, Laboratoire de Geologie et Mineralogie, Alger, Algeria.
Runner, Delmar G., 4606 47 Street, N.W., Washington, D.C.
*Runner, Joseph J., State University of Iowa, Iowa City, Iowa.
*Rutherford, Ralph L., University of Alberta, Edmonton, Alberta, Canada.
Ruthruff, Robert F., 1711 West 100 Street, Chicago, Illinois.
Rynearson, Garn A., Department of Geology, Lehigh University, Bethlehem, Pennsylvania.

Sachs, Walter P., 254 Bloomfield Avenue, Caldwell, New Jersey.
Saletel, Louis, University of Dayton, Dayton, Ohio.
*Sampson, Edward, Princeton University, Princeton, New Jersey.
Sandberg, Adolph E., Box 1138, Ancon, Canal Zone.
Sayers, R. R., National Health Institute, 25th and E Streets, N.W., Washington, D.C.
*Schairer, John F., Geophysical Laboratory, Washington, D.C.
*Schaller, Waldemar T., U. S. Geological Survey, Washington, D.C.
Schlocker, J., Box 554, Boulder City, Nevada.

Schmitt, Harrison, Box 572, Silver City, New Mexico.
*Schneider, Hyrum, University of Utah, Salt Lake City, Utah.
Schoenlaub, R. A., 150½ Miami Street, Tiffin, Ohio.
*Schoep, Alfred, University of Ghent, Ghent, Belgium.
*Schrader, Frank C., 20 Old Chester Road, Bethesda, Maryland
Schwartz, B., 757 East 169 Street, Bronx, New York.
*Schwartz, G. M., Université Laval, Quebec, Canada.
Setz, C. F., 7720 Club Drive, St. Louis, Missouri.
Shackelford, G. E., 4340 Fairfax Avenue, Dallas, Texas.
*Shand, S. James, Department of Geology, Columbia University, New York, New York
*Shaub, Benjamin M., 123 South Street, Northampton, Massachusetts.
Sherman, Walter C., 27 Doro Place, Rumford, Rhode Island.
Shipton, W. D., Department of Geology, Washington University, St. Louis, Missouri.
*Short, Max N., University of Arizona, Tucson, Arizona.
Shortle, Walter, 505 Main Street, Laconia, New Hampshire.
Sideri, D. I., Selskokhosjastvennij In T., Korpus 2 dv. 6, Voronezh 1, U.S.S.R.
Siemer, Carleton A., 150 Beach Street, Stapleton, New York.
Silbersten, M. L., 516 Sul Ross Avenue, Houston, Texas.
Silver, Caswell, 309 South Buena Vista, Albuquerque, New Mexico.
Simpson, William K., 109 East 91 Street, New York, New York.
*Singewald, Quentin D., University of Rochester, Rochester, New York.
Skea, E. M., P. O. Box 46, Pilgrims Rest, Transvaal, South Africa.
*Slawson, Chester B., University of Michigan, Ann Arbor, Michigan.
Smalling, Elmer, Jr., 7029 Lincoln Drive, Philadelphia, Pennsylvania.
Smirnov, S. S., Vasilievskij Ostrov, 11 Linia 12/32 kv. 15, Leningrad, U.S.S.R.
Smith, D. T., Rensselaer Polytechnic Institute, Troy, New York.
Smith, H. A., 12821½ St. Clair Avenue, Cleveland, Ohio.
Smith, Harold M., Cumberland Hill Road, Manville, Rhode Island.
Smith, Knowles B., Department of Mining Engineering, University of Notre Dame, Notre Dame, Indiana.
Smith, Peter A., Box 183, Highland Mills, New York.
Smith, Robert L., Fair Oaks, California.
Smith, Walden A., Ilwaco, Washington.
*Snelgrove, Alfred K., Michigan College of Mining and Technology, Houghton, Michigan.
Sniffen, E. W., 3111 Boulevard, Hampton, Virginia.
Snow, Roland B., Research Laboratory, U. S. Steel Corporation, Kearny, New Jersey.
Sohlberg, Rudolph G., 810 U. S. National Bank Building, Denver, Colorado.
*Spence, Hugh S., Canada Department of Mines, Ottawa, Canada.
Spiroff, Kiril, 322 North State Street, Ann Arbor, Michigan.
Sproat, Ira E., Gorham Avenue, Westport, Connecticut.
Stadnichenko, Taisia, U. S. Geological Survey, Washington, D.C.
*Stanton, Gilman S., 245 West 104 Street, New York, New York.
*Staples, Lloyd W., Department of Geology, University of Oregon, Eugene, Oregon.
Starbird, Leonard H., 48 Clinton Street, South Portland, Maine.
*Stark, John T., Northwestern University, Evanston, Illinois.
Stead, Frank, 1420 Grand Concourse, New York, New York.
Steedman, R. D., 17 Saville Row, Newcastle on Tyne, England.
*Steiger, George, U. S. Geological Survey, Washington, D.C.
Stevens, R. E., U. S. Geological Survey, Washington, D.C.

Stevenson, John S., 902 McClure Street, Victoria, British Columbia, Canada.
Stevenson, Mrs. John S., 902 McClure Street, Victoria, British Columbia, Canada.
Stewart, Duncan, Carleton College, Northfield, Minnesota.
Stobbe, Helen, Baldwin House, Northampton, Massachusetts.
Stoiber, Richard E., 17 Downing Road, Hanover, New Hampshire.
Stow, Marcellus, 202 McDowell Street, Lexington, Virginia.
Stringham, Bronson, University of Utah, Salt Lake City, Utah.
*Stuckey, Jasper L., 1911 Sunset Drive, Raleigh, North Carolina.
Suda, John S., P. O. Box 305, Station "D," Cleveland, Ohio.
Sueno, Teiroku, 484 Chome, Tamagawa-Okusawa-cho, Setagaya-ku, Tokyo, Japan.
Suffel, G. G., Noranda, Quebec, Canada.
Sugi, Ken-ichi, Ohori-machi 157, Fukuoka, Japan.
Swartzlow, Carl, Lassen Volcanic National Park, Mineral via Red Bluff, California.
Swayne, W. H., Department of Geology, Anaconda Copper Company, Butte, Montana.
Sweeney, Wilbur A., 510 2nd Avenue, Webster City, Iowa.
Switzer, George, Department of Geology, Yale University, New Haven, Connecticut.

*Taber, Stephen, University of South Carolina, Columbia, South Carolina.
Tatge, Eleanor, 5811 14 Street N.W., Washington, D.C.
Taylor, Edward D., Universite Laval, Boulevard de l'Entente, Quebec, Canada.
Taylor, Ralph E., P. O. Box 1520, New Orleans, Louisiana.
Terpstra, P., Mineralogisch Kristallographisch Institut des Ryks Universität, Gronigen, Holland.
Thibault, Newman W., Norton Company, Worcester, Massachusetts.
Thomas, George M., 310 North Euclid Avenue, Westfield, New Jersey.
Thomas, W. Hersey, 145 East Gorgas Lane, Mt. Airy, Philadelphia, Pennsylvania.
Thompson, M. R., Bureau of Mines, Norris, Tennessee.
*Thomson, Ellis, University of Toronto, Toronto, Ontario, Canada.
Thune, Howard W., School of Mines, University of Idaho, Moscow, Idaho.
*Tolman, Carl, Washington University, St. Louis, Missouri.
Tomlinson, W. Harold, 114 Yale Avenue, Swarthmore, Pennsylvania.
Toothaker, Charles R., Commercial Museum, 34th and Spruce Streets, Philadelphia, Pennsylvania.
Townsend, Roland C., Department of Geology, University of Wisconsin, Madison, Wisconsin.
Toyoda, Hideyoshi, c/o Sumitomo-koshi, No. 5, 2-tiao, Tung-sen-pai-low, Peking, China.
Trainer, David W., Jr., 48 Payne Street, Hamilton, New York.
Trainer, J. N., 233 East 62 Street, New York, New York.
Trimble, Clinton E., 2903 Dalton Avenue, Los Angeles, California.
Trudell, Harry W., 303 Highland Avenue, Abington, Pennsylvania.
*Tunell, George, Geophysical Laboratory, Washington, D.C.
Turner, D. S., 1118 Waban Hill, Madison, Wisconsin.
Tuthill, Isabel H., Rocky Point, New York.

Uklonskij, A. S., Ul. K. Marksa 59, kv. 8, Tashkent, U.S.S.R.
Upson, Charles G., Box 334, Houghton, Michigan.

Vance, R. C., Woodland Road, Long Meadow, Pittsford, New York.
Vanderkike, Paul, Route 5, Box 128, Bakersfield, California.
*Vernadsky, Vladimir, Moscow, 2, Durnovsky per 1^{d}, kv. 2, U.S.S.R.

Vesignie, Jean Paul Louis, 22 Rue du General Foy, Paris, France.
Vieweg, Hermann F., 323 Lawrence Avenue, Highland Park, New Jersey.
Vigfusson, V. A., University of Saskatchewan, Saskatoon, Saskatchewan, Canada.
Vitaliano, Charles J., Department of Ceramics, Rutgers University, New Brunswick, New Jersey.
*Von Schlichten, Otto, University of Cincinnati, Cincinnati, Ohio.
*Vonsen, M., Petaluma, California.

Wade, F. Alton, 1634 Wagar Avenue, Lakewood, Ohio.
Wager, Lawrence R., The University of Reading, England.
Wahlstrom, E. E., Department of Geology, University of Colorado, Boulder, Colorado.
Waldo, Allen W., 1335 North Van Buren, Stockton, California.
Waldschmidt, W. A., 4840 Tennyson Street, Denver, Colorado.
*Walker, Thomas L., 20 East Avondale Road, Toronto, Ontario, Canada.
*Wallace, Robert C., Queen's University, Kingston, Ontario, Canada.
Walter, Charles, Jr., Caprock, New Mexico.
Walther, P., 508 Muriel Parkway, Elizabeth, New Jersey.
*Wandke, Alfred, Guanajuato Consolidated Mining Co., Guanajuato, Mexico.
Warner, Robert E., 2980 Pingree Avenue, Detroit, Michigan.
Warrach, Henry C., Box 1734, Bakersfield, California.
Wasserstein, B., Geological Survey, Union of South Africa, Pretoria, South Africa
*Watanabe, Manjiro, Tohoku Imperial University, Sendai, Japan.
Watanabe, Takeo, Hokkaido Imperial University, Sapporo, Japan.
*Watson, E. H., Bryn Mawr College, Bryn Mawr, Pennsylvania.
Watson, Kenneth deP., Department of Geology, Princeton University, Princeton, New Jersey.
Webb, Robert, Department of Geology, University of California at Los Angeles, California.
Wedel, Arthur, Box 849, Santa Paula, California.
Weeks, Charles A., Red Gate Lane, Meredith, New Hampshire.
Weidhaas, Ernest, 63 Iden Avenue, Pelham Manor, New York.
*Weidman, Samuel, 512 Lahoma Street, Norman, Oklahoma.
Wellman, Walter L., 2205 Alamo Drive, Albuquerque, New Mexico.
Wellnitz, Anna M., Brooklyn College, Brooklyn, New York.
*Wells, Roger C., U. S. Geological Survey, Washington, D.C.
West, C. D., Polaroid Corporation, 718 Main Street, Cambridge, Massachusetts.
*Westgate, Lewis G., 124 Oak Hill Avenue, Delaware, Ohio.
*Wherry, Edgar T., 27 Oberlin Avenue, Swarthmore, Pennsylvania.
Whitaker, George C., Schaaf Road, R.D. 3, Brooklyn Station, Cleveland, Ohio.
White, George W., University of New Hampshire, Durham, New Hampshire.
*Whitlock, Herbert P., American Museum of Natural History, New York, New York.
Whitmore, Duncan R. E., 71 Graduate College, Princeton, New Jersey.
*Wigglesworth, Edward, Boston Society of Natural History, 234 Berkeley Street, Boston, Massachusetts.
Wilke, R. M., Palo Alto, California.
Wilkinson, W. D., Oregon State Agricultural College, Corvallis, Oregon.
Willems, H. W., 145 Pearl Street, Corning, New York.
Willey, L. M., Research Laboratory, General Electric Company, Schenectady, New York.
Williams, Charles R., 11 Thackeray Road, Wellesley Hills, Massachusetts.

Williams, Norman C., 762 8th Avenue, Salt Lake City, Utah.
Willis, Willett R., 1343 North Nevada Avenue, Colorado Springs, Colorado.
Wilson, Ernest H., Shelton Hotel, 49th and Lexington Ave., New York, New York.
*Winchell, Alexander N., University of Wisconsin, Madison, Wisconsin.
Winchell, Horace, Geological Museum, Harvard University, Cambridge, Massachusetts.
Wishart, James S., 56 Hammond Street, Rochester, New York.
Withers, Gilbert W., Withers Gem and Mining Corporation, 228 Peachtree Arcade, Atlanta, Georgia.
Withrow, James R., 77 16th Avenue, Columbus, Ohio.
Wolfe, C. W., Department of Mineralogy, Harvard University, Cambridge, Massachusetts.
*Woodford, Alfred O., 443 West 10th Street, Claremont, California.
Woodhouse, C. D., 33 Mimosa Lane, Santa Barbara, California.
Woodruff, T. L., St. Louis Sampling and Testing Works, 3480 Morganford Road, St. Louis, Missouri.
Woods, Arthur E., 16 Elliott Place, East Orange, New Jersey.
Woodward, Horace A., 43 Lowell Avenue, West Orange, New Jersey.
*Wright, Frederick E., Geophysical Laboratory, Washington, D.C.
Wright, Thomas A., 1161 Stillman Avenue, Plainfield, New Jersey.

Yagi, Kenzo, Mineralogical Institute, Tohoku Imperial University, Sendai, Japan.
Yardley, Martyn H., 8628 Southgate Avenue, Southgate, California.
Young, Ford, Department of Geology, Columbia University, New York, New York.
Young, John A., Jr., Michigan State College, East Lansing, Michigan.

Zeihen, Lester G., Chile Exploration Company, Chuquicamata, Chile.
Zeman, Frederic D., 111 East 88 Street, New York, New York.
Zerfoss, Samuel, Department of Ceramics, Pennsylvania State College, State College, Pennsylvania.
Zimanyi, D. F., Magyar Nemzeti Museum, Budapest, Hungary.
Zimmer, Paul W., 86 Woodruff Street, Columbus, Ohio.
Zodac, Peter, Box 29, Peekskill, New York.

SUBSCRIBERS

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Brooklyn Children's Museum Library, Brooklyn Avenue and Park Place, Brooklyn, New York.
Brown University Library, Providence, Rhode Island.
Bruns, F., Bokhandel, Trondheim, Norway.
Bryn Mawr College Library, Bryn Mawr, Pennsylvania.
Buffalo Museum of Science Research, Library, Humbolt Street, Buffalo, New York.

California Institute of Technology, Pasadena, California.
California Junior College Library, Terracina Drive, Riverside, California.
California State Division of Mines, Ferry Building, San Francisco, California.
Caribbean Petroleum Company, Geological Department, Apartado 19, Maracaibo, Venezuela.
Carleton College Library, Northfield, Minnesota.
Carnegie Institute of Technology, Science Library, College of Engineering, Schenley Park, Pittsburgh, Pennsylvania.
Carnegie Library of Pittsburgh, Schenley Park, Pittsburgh, Pennsylvania.
Carnegie Public Library, Grand Junction, Colorado.
Case School of Applied Science, Department of Geology and Mineralogy, Cleveland, Ohio.
Centraljnoj Geologicheskoj Biblioteke, Vasil Ostrov, Musorgskogo 72-B, Leningrad, U.S.S.R.
Champion Spark Plug Company, Ceramic Division, 8525 Butler Avenue, Detroit, Michigan.
Charles University, Mineralogical Institute, Albertov 6, Praha, Czechoslovakia.
Chishitsu Chosasho, Hsinking, Manchukuo, via Japan.
Chishitsu-Kobutsu, Rigkubu, Hokkaido Teikoku Daigaku, Sapporo, Japan.
Chichitsugaku-Kyoshitsu, Tokyo Imperial University, Tokyo, Japan.
Clark University Library, Worcester, Massachusetts.
Cleveland Public Library, 325 Superior Avenue, N.E., Cleveland, Ohio.
College of the City of New York, Convent Avenue and 139th Street, New York, New York.
Colorado College, Coburn Library, Colorado Springs, Colorado.
Colorado School of Mines Library, Golden, Colorado.
Colorado Springs Mineralogical Society, 1340 North Wahsatch, Colorado Springs, Colorado.
Columbia University Library, New York, New York.
Commissioner of Lands and Mines, Georgetown, British Guiana.
Cornell University Library, Ithaca, New York.
Cranbrook Institute of Science, Bloomfield Hills, Michigan.

Daiichi Koto Gakko Toshokan, Komaba, Tokyo, Japan.
Dartmouth College Library, Hanover, New Hampshire.
Denver Public Library, Science and Engineering Department, Denver, Colorado.
Departement van Economische Zaken, Bibliotheek, Groote Weg 20, Buitenzorg, Java, Dutch East Indies.
Department of Mines, Victoria, British Columbia, Canada.
Department of Natural Resources, Division of Mines, Atlanta, Georgia.
Departamento de Minas y Petroleo, Casilla 3967, Santiago, Chile.
Departmento Nacional da Produccao Mineral Bibliotheca, Avenida Pasteur 404 Rio de Janeiro, Brazil.
DePauw University Library, Greencastle, Indiana.
Detroit Public Library, Woodward and Kirby Avenues, Detroit, Michigan.
Deutsche Chemische Gesellschaft, Sigismundstrasse 4, Berlin W 35, Germany.
Dow Chemical Company Library, Midland, Michigan.
Dra. Z. Ch. de Cetrangelo, Crisostomo Alvarez 616, Tucuman, Argentina.
Duke University Library, Durham, North Carolina.

Earlham College Library, Richmond, Indiana.
Ecole Nationale Superiore des Mines, Bibliotheque, 60 Boulevard St., Michel, Paris, France.
Ecole Polytechnique, 1430 Rue St. Denis, Montreal, Canada.
Eidgenössische Technische Hochschule, Mineralogisch-petrographisch Institut, Sonneggstrasse 5, Zurich, Switzerland.
Engineering Societies Library, 29 West 39 Street, New York, New York.

Field Museum of Natural History, Chicago, Illinois.
Fock, Gustav, Buchhandlung, Sternwartenstrasse 8, Leipzig C1, Germany.
Foote Mineral Company, 1609 Summer Street, Philadelphia, Pennsylvania.
Fremont Public Library, Lander, Wyoming.
Fresno State Teachers College Library, Fresno, California.
Frommansche Buchhandlung, Jena, Germany.

Garcia, Valentin, y Cia., Apartado 2103, Habana, Cuba.
Geological Institute, Tokyo Imperial University, Tokyo, Japan.
Geological Society of America, 419 West 117 Street, New York, New York.
Geological Society of London, Burlington House, Piccadilly, London W.1, England.
Geological Survey of Canada, Department of Mines and Resources, Victoria Memorial Museum, Ottawa, Canada.
Geological Survey of Great Britain, Exhibition Road, London SW.7, England.
Geological Survey of India, 27 Chowringhee Road, Calcutta, India.
Geological Survey of New Zealand, 156, The Terrace, Wellington, C.I., New Zealand.
Geological Survey of South Africa, Department of Mines, Pretoria, South Africa.
Geological Survey of Southern Rhodesia, Salisbury, Southern Rhodesia, Africa.
Geologich Upravlenija, Biblioteke Uzbekskogo, Ul. Shevchenko D. 11, Tashkent, U.S.S.R.
Geologich Upravlenija, Gruzinsk SSSR, Ul. Dzerzhinskogo 19, Tbilisi, U.S.S.R.
Geologisk Museums Bibliotek, Trondhjemsveien 23, Oslo, Norway.
Geophysical Laboratory, 2801 Upton Street, Washington, D.C.
Georgia School of Technology Library, Atlanta, Georgia.
Giredmet Nauchn. Tekhn. Biblioteke, Zubowskaja Ul. 7/17, Moscow 21, U.S.S.R.
Glaw. Pochtamt, P/Ja 500/818, Moscow, U.S.S.R.

Gleerupska, A. B., Univ.-Bokhandeln, Lund, Sweden.
Gos. Biblioteke Wseukr. Akad. Nauk, Ul. Korolenko No. 58 A., Kiev, U.S.S.R.
Government Mineralogist, Torrington Square, Colombo, Ceylon.
Government Research Institute Library, Taihoku, Taiwan, Japan.
Gozud Publ. Bib. Kazakhstana, Pr. Lenina 11, Alma Ata, KssR, U.S.S.R.

Hamilton College Library, Clinton, New York.
Hantzschel, Ludwig, and Company, Göttingen, Germany.
Harbison-Walker Refractories Company, Hays Laboratory, Box 443, Homestead, Pennsylvania.
Harrassowitz, Otto, Braus-Riggenbach, Basel, Switzerland.
Harvard University, Department of Mineralogy Library, Cambridge, Massachusetts.
Hecla Mining Company, Burke, Idaho.
Hiroshima Koto Gakko, Toshoka, Minami-cho, Hiroshima, Japan.
His Majesty's Stationery Office, Princes Street, Westminster, London, S.W.1, England.
Hogana-Billesolms A/B, Biblioteket, Hoganas, Sweden.
Hokkaido Kogyo Shikenjo, Kotonimura, near Sapporo, Hokkaido, Japan.

Idaho University Library, Moscow, Idaho.
Imperial College of Science and Technology, South Kensington, London S.W.7, England.
Indian School of Mines, Dhanbad, India.
Industry Bureau, Archives and Library, South Manchuria Railway Company, Dairen, Manchuria.
Institute of Physical and Chemical Research Library, Komagome, Hongo-ku, Tokyo, Japan.
Instituto de Geologia, Avenida San Martin, Caracas, Venezuela.
International Annual Tables, Institute de Chemie, 18 Rue Pierre-Curie, Paris, France.
International Nickel Company of Canada, Ltd., Copper Cliff, Ontario, Canada.
Iowa State College Library, Ames, Iowa.
Ishihara Sangyo Kaiun K. Kaisha, Shinko Building, 8, Kaigandori, Kobe-ku, Kobe, Japan.
Ishihara Sangyo Kaiun Kaisha, Kigyoka, 1, Edobori Kami-dori, 1-chome, Niskiku, Osaka, Japan.

Jakutskomu Geologisheskomu Upravlenija, Ul. Chernyshevskogo 62, Jakutsk, U.S.S.R.
Johannesburg Public Library, Johannesburg, South Africa.
John Crerar Library, Chicago, Illinois.
Johns Hopkins University Library, Baltimore, Maryland.
Johns-Manville Research Laboratories, Manville, New Jersey.
Junior College Library, Bay City, Michigan.

Kansas City Public Library, 9th and Locust Street, Kansas City, Missouri.
Kansas State Agricultural College Library, Manhattan, Kansas.
Kazakstanskij Filial, Akademii Nauk, Ul. Vinogradova 18, Alma Ata, U.S.S.R.
Kaz. Gorno. Metallurg. Institut, Prospekt Lenina 79, Alma-Ata, Kazakhstan, U.S.S.R.
Knizhnyi Otedel, Akademii Nauk U.S.S.R., Ul. Kropotkina 16, Moscow 34, U.S.S.R.
Koehlers Antiquarium, K. F., Taubschenweg 21, Leipzig C1, Germany.
Kol Skaja Baza, Akademii Nauk, Apatitovaja Gora, Murm. Okr. Kirovsk, U.S.S.R.
Komuka Taiwan, Sotokufu Shokusan Kyoku, Taihoku, Taiwan, Japan.
Kungl. Veteskapskademiens Bibliotek, Stockholm, Sweden.
Kyushu Imperial University, Geological Institute, Fukuoka, Japan.

L. G. I., Glawnoi Biblioteke, W.O. 21 Linija 2, Leningrad, U.S.S.R.
Lafayette College Library, Easton, Pennsylvania.
Lago Petroleum Corporation, Apartado 172, Maracaibo, Venezuela.
Lehigh University Library, Bethlehem, Pennsylvania.
Librarie Falk Fils, 22 Rue des Paroissiens, Brussels, Belgium.
Library of Congress, Washington, D.C.
Libreria Hachette, Maipu 49, Casilla Especial 6, Buenos Aires, Argentina.
Libreria Internazionale Minerva, Via Pietro da Cortona 1, Rome, Italy.
Libreria Nistri-Lischi, Piazza S. Felice 2, Pisa, Italy.
Los Angeles County Public Library, 322 South Broadway, Los Angeles, California.
Los Angeles Public Library, 5th and Broadway, Los Angeles, California.
Louisiana State University Library, University, Louisiana.

Maine Mineralogical and Geological Society, 6 Allen Avenue, Portland, Maine.
Marshall College Library, Huntington, West Virginia.
Maryland Academy of Sciences, 2724 North Charles Street, Baltimore, Maryland.
Massachusetts Institute of Technology Library, Cambridge, Massachusetts.
Massachusetts State College, Goodell Library, Amherst, Massachusetts.
Mayerische, J. A., Buchel 43, Aix-la-Chapelle, Germany.
McGill University, Library, 3459 McTavish Street, Montreal, Canada.
Mechanics Mercantile Library, 57 Post Street, San Francisco, California.
Metal and Thermit Corporation, 120 Broadway, New York, New York.
Michigan College of Mines and Technology Library, Houghton, Michigan.
Michigan State College Library, East Lansing, Michigan.
Mineralogisches Institut de Universität, Bonn a. Rh., Germany.
Mineralogisches Institut der Universität, Bertholdstrasse, Freiburg, Germany.
Mineralogisches-petrographisches Institut der Universität, Göttingen, Germany.
Mineralogisch-geologisches Institut der Universität, Wismarschestrasse 8, Rostock, Germany.
Mineralogische Staatssammlung, Neuhauserstrasse 51, München 2M, Germany.
Ministere Mines and Pecheries, Chambre E-605, Hotel du Gouvernment, Quebec, Canada.
Missouri School of Mines and Metallurgy Library, Rolla, Missouri.
Montana School of Mines, Butte, Montana.
Montana State University Library, Missoula, Montana.
Morioka Technical College, Morioka, Japan.
Moskovsky Geologo-Razvedotschny Institut Biblioteke, Mokhovaja II, Moscow, U.S.S.R.
Mount Holyoke College Library, South Hadley, Massachusetts.
Muroran-Koto-Kogyo-Gakko, "Toshoka," Muroran, Hokkaido, Japan.
Museo Civico di Storia Naturale, Giardini Pubblici, Corso Venezia, Milan, Italy.
Museo di Storia Naturale, Director, Giardini Pubblici, Corso Venezia, Milan, Italy.
Myers, H. S. and Sons Company, Box 287, Greencastle, Indiana.

National Geological Survey of China, Pehpei, Chungking, Szechuan, China.
National Institute of Geology, Academia Sinica, Box 138, Kweilin, Kwangsi, China.
National Library of Peiping, c/o Fung Ping Shan Library, 94, Bohham Road, Hong Kong, China.
National Lime and Stone Company Laboratory, Carey, Ohio.
Nautschnoj Biblioteke, Narkomtjazazhproma Delovoj Dvor IV, Podjesd, Moscow, U.S.S.R.
New Jersey Zinc Company Library, Franklin, New Jersey.

New Jersey Zinc Company, 160 Front Street, New York, New York.
New Mexico State School of Mines, Socorro, New Mexico.
New York Mineralogical Club, Inc., American Museum of Natural History, New York, New York.
New York Public Library, 476 Fifth Avenue, New York, New York.
New York State Library, Albany, New York.
New York University Library, University Heights, New York, New York.
New York University, Washington Square Library, 100 Washington Square East, New York, New York.
Newark Mineralogical Society, 468 Orange Street, Newark, New Jersey.
Newark Museum Association, 49 Washington Street, Newark, New Jersey.
Nigrisoloto im Kosarewa Biblioteke, Worobjewi Gori 47A, Moscow, U.S.S.R.
Nordemann Publishing Company, 215 Fourth Avenue, New York, New York.
North Carolina State College of Agriculture and Engineering, State College Station, Raleigh, North Carolina.
North Texas Agricultural College Library, Arlington, Texas.
Northwestern University Library, Evanston, Illinois.

Oberlin College Library, Oberlin, Ohio.
Occidental College Library, Los Angeles, California.
Ohio State University Library, Columbus, Ohio.
Oklahoma Agricultural and Mechanical College Library, Stillwater, Oklahoma.
Oon Akademii Nauk Fund. Biblioteke, Uliza Frunze 11, Moscow 19, U.S.S.R.
Oregon State Agricultural College Library, Corvallis, Oregon.
Otago University Library, Dunedin, New Zealand.

P. G. U. Fundament. Biblioteke, Zaimka Ul. Genkelja 1, Permj, U.S.S.R.
Pasadena Junior College, Hill and Colorado Streets, Pasadena, California.
Pennsylvania State College, School of Mineral Industries, State College, Pennsylvania.
Philadelphia Mineralogical Society, Academy of Natural Science, Logan Circle, Philadelphia, Pennsylvania.
Pomona College Library, Claremont, California.
Preussische Staats-Bibliothek, Unter den Linden 38, Berlin N.W. 7, Germany.
Princeton University Library, Princeton, New Jersey.

Queen's University Library, Kingston, Ontario, Canada.

R. Universita, Istituto di Mineralogia, Messina, Italy.
R. Universita, Istituto di Mineralogia, Via dell' Universita 5, Modena, Italy.
R. Universita, Istituto di Mineralogia, Padova, Italy.
R. Universita, Istituto di Geodesia, Via Archirafi, Palermo, Italy.
R. Universita, Istituto di Mineralogia, Via Archirafi, Palermo, Italy.
R. Universita, Istituto di Mineralogia, Viale Taramelli, Pavia, Italy.
R. Universita, Istituto di Mineralogia, Pisa, Italy.
Rautatiekirjakauppa, Koydenpunojankatu 2, Helsingfors, Finland.
Reichszentrale für Wissenschaftliche Berichterstattung, Unter den Linden 38, Berlin N.W. 7, Germany.
Reitzel, C. A., Norregade 20, Copenhagen K. Denmark.
Rhode Island State College Library, Green Hall, Kingston, Rhode Island.
Rhodes University College, Grahamstown, South Africa.

Rochester Public Library, 115 South Avenue, Rochester, New York.
Rohmkopf, Emil, Buch. Antiquariat, Konigstrasse 19, Leipzig, Germany.
Rosenberg and Sellier, 14 Via Andrea Doria, Turin, Italy.
Royal Ontario Museum of Mineralogy, 100 Queen's Park, Toronto 5, Canada.
Rumrill, Charles L. and Company, 364 East Avenue, Rochester, New York.
Rutgers University Library, New Brunswick, New Jersey.
Ryojun College of Engineering, Port Arthur, South Manchuria.

St. Louis University Library, St. Louis, Missouri.
San Diego Society of Natural History, Balboa Park, San Diego, California.
San Diego State College Library, San Diego, California.
Santa Ana Public Library, Santa Ana, California.
Scientific Library Division, P.O. Box 774, Manila, Philippine Islands.
Scripps Institute of Oceanography, Library, La Jolla, California.
Servicio da Producao Mineral, Secretario da Agricultura Bello Horizonte, Minas Geraes, Brazil.
Shanghai Science Institute, Central Library, 320 Route Ghizi, Shanghai, China.
Smith, W. H. and Son, 71–75 Boulevard Adolphe Max, Brussels, Belgium.
Smith College Library, Northampton, Massachusetts.
Sociedad Cientifica Argentina, Santa Fe 1145, Buenos Aires, Argentina.
South Dakota State School of Mines Library, Rapid City, South Dakota.
Southern Methodist University Library, Dallas, Texas.
Spencer Lens Company, Buffalo, New York.
Stanford University Library, Stanford University, California.
State Agricultural Library, Wageningen, Geld., Holland.
State University of Iowa, Library, Iowa City, Iowa.
Steven, B. F. and Brown, 28–30 Little Russell Street, London W.C. 1, England.
Sveriges Geologiska Undersokning, Stockholm 50, Sweden.
Syracuse University Library, Syracuse, New York.

T. D. F., c/o Maruzen Company, Kokubun-machi, Sendai, Japan.
Taihoku Imperial University Library, Taihoku, Taiwan, Japan.
Tairiku, c/o Maruzen Company, Osaka Branch, Bakuromachi, Osaka, Japan.
Technische Hochschule, Institute fur Mineralogie, Berlin Charlottenburg, Germany.
Teknich. Biblioteke Tresta Russkij, Samocvety, Nab. Lejtenanta Shmidta 34, Pocht. Otd Leningrad, U.S.S.R.
Texas College of Mines and Metallurgy Library, El Paso, Texas.
Texas Technological College Library, Lubbock, Texas.
Thin, James, 54 South Bridge Street, Edinburgh, Scotland.
Thomas and Hochwalt Laboratories, Monsanto Chemical Company, Dayton, Ohio.
Tokyoshibaura-Denki Co. Ltd., Kawasaki-shi, Kanagawa-ken, Japan.
Tufts College Library, Tufts College 57, Massachusetts.

Union Carbide and Carbon Research Laboratories, Inc., 4625 Royal Avenue, Niagara Falls, New York.
Union College Library, Schenectady, New York.
United States Bureau of Mines, c/o University of Utah, Salt Lake City, Utah.
United States Commissary, Box 1733, 57349 Carnahan, Atlanta, Georgia.
United States Geological Survey Library, Washington. D C.
United States National Museum, Washington, D.C.

Universidad Nacional de Mexico Library, Calle del Lic. Verdad No. 2, Mexico, D.F., Mexico.
Universitats Bibliothek, Kiel, Germany.
University Library, Cambridge, England.
University, Department of Mineralogy and Petrology, Cambridge, England.
University, Radcliffe Library, Oxford, England.
University Library, Stellenbosch, South Africa.
University Library, Adelaide, South Australia.
University College of Swansea Library, Singleton Park, Swansea, England.
University of Arizona Library, Tucson, Arizona.
University of Arkansas Library, Fayetteville, Arkansas.
University of British Columbia, Point Grey, British Columbia, Canada.
University of Buffalo, Library, 3425 Main Street, Buffalo, New York.
University of Calcutta, Geological Department, Calcutta, India.
University of California Library, Berkeley, California.
University of California at Los Angeles, Los Angeles, California.
University of Cape Town Library, Rondebosch, Cape Town, South Africa.
University of Chattanooga Library, Chattanooga, Tennessee.
University of Chicago Libraries, Chicago, Illinois.
University of Cincinnati Library, Burnett Woods Park, Cincinnati Ohio.
University of Colorado Library, Boulder, Colorado.
University of Georgia Library, Athens, Georgia.
University of Hawaii Library, Honolulu, Hawaii.
University of Illinois Library, Urbana, Illinois.
University of Kansas Library, Lawrence, Kansas.
University of Kentucky Library, Lexington, Kentucky.
University of Liege, Geological Laboratory, Liege, Belgium.
University of Louvain Library, Place du People, Louvain, Belgium.
University of Manchester Library, Manchester, England.
University of Manitoba Library, Winnipeg, Manitoba, Canada.
University of Melbourne Library, Carlton N. 3, Victoria, Australia.
University of Michigan Library, Ann Arbor, Michigan.
University of Minnesota Library, Minneapolis, Minnesota.
University of Missouri Library, Columbia, Missouri.
University of Nevada Library, Reno, Nevada.
University of New Hampshire, Hamilton Smith Library, Durham, New Hampshire.
University of New Mexico Library, Albuquerque, New Mexico.
University of North Carolina Library, Chapel Hill, North Carolina.
University of North Dakota Library, University, North Dakota.
University of Oklahoma Library, Norman, Oklahoma.
University of Oregon Library, Eugene, Oregon.
University of Pennsylvania Library, Philadelphia, Pennsylvania.
University of Pittsburgh Library, 310 State Hall, Pittsburgh, Pennsylvania.
University of Pretoria Library, Pretoria, South Africa.
University of Reading, Library, Reading, England.
University of Rochester Library, Rochester, New York.
University of St. Andrews Library, St. Andrews, Scotland.
University of South Dakota Library, Vermilion, South Dakota.
University of Southern California Library, University Park, Los Angeles, California.

University of Stockholm, Mineralogical Department, Drottninggatan 118, Stockholm, Sweden.
University of Sydney, Fisher Library, Sydney, New South Wales, Australia.
University of Texas Library, Austin, Texas.
University of Toronto, Library, Toronto, Ontario, Canada.
University of Utah, Geology Department, Salt Lake City, Utah.
University of Virginia Library, Charlottesville, Virginia.
University of Washington Library, Seattle, Washington.
University of West Virginia Library, Morgantown, West Virginia.
University of Western Australia, Library, Perth, Western Australia.
University of Wisconsin Library, Madison, Wisconsin.
University of the Witwatersrand Library, Johannesburg, South Africa.
University of Wyoming Library, Laramie, Wyoming.
Uralskij Filial Akademii Nauk, Ul. Malycheva 31/8, Sverdlovsk, U.S.S.R.
Uraljskoje Geologicheskoje Upravlenije, Ul. Vainera N. 55, Sverdlovsk, U.S.S.R.
Usb. Filiala Akad. Nauk Biblioteke, Ul. A. Tukaewa N. 1, Tashkent, U.S.S.R.

Vanadium Corporation of America Library, Bridgeville, Pennsylvania.
Vanderbilt University, Department of Geology, Nashville, Tennessee.
Vsegei, Byvsh In. T. Min. Syrja, Pyzhevskij Per 7, Moscow 17, U.S.S.R.

Ward's Natural Science Establishment, Rochester, New York.
Washington State College Library, Pullman, Washington.
Washington University Library, St. Louis, Missouri.
Wayne Laboratories, 17 East Main Street, Waynesboro, Pennsylvania.
Wellesley College Library, Wellesley, Massachusetts.
Wesleyan College Library, 175 North Street, Middletown, Connecticut.
Wichita City Library, Wichita, Kansas.

Yale University, Brush Mineralogical Library, Kirtland Hall, New Haven, Connecticut.
Young, Henry, and Sons, Ltd., 12 South Castle Street, Liverpool, England.

BOOK REVIEWS

GEOLOGY OF COAL, by Otto Stutzer and Adolph C. Noé. 461+xiii pages, 198 figures, University of Chicago Press. 1940. Price $5.00.

The book is in part a translation of the second edition of *Kohle* by Otto Stutzer, and in part a translation of a revision and abbreviation of certain chapters of that edition by Professor Stutzer. The translation, with a few modifications and additions, was nearly completed by the late Professor Adolph C. Noé of the University of Chicago at the time of his death. Competent scientific associates gathered up the loose threads and with certain editorial revision regarding the translation of German coal names the book appears as a highly authoritative and exhaustive treatise of coal, and one that is also easily readable and usable by Americans.

The botanical microscopic examination of coal and the petrography of coal beds; the chemical composition; the origin of coal and coal beds; the classification; the nature of associated rocks; the age, size, and extent of the deposits; the structural features; the factors that determine ease of recovery; the stratigraphy of coal deposits—all are treated in detail. Many interesting but less important features are described such as the weathering of coal, the origin of eye coal, coal breccia, coal pebbles, coal balls, pyrite and other minerals, oil in coal beds, relation to oil shales, and destruction of coal beds by water and ice. The sections on the processing of coal and the application of petrography thereto should prove new and valuable to many persons engaged in the coal industry.

The complex structures of the coal beds in various German fields are described and illustrated at length. In most of our bituminous fields we will not be mining coal under such complex conditions for many years, and perhaps, from a practical standpoint this subjct has been dealt with too extensively. The section is certainly of considerable interest, however.

Professor Noé planned, it is believed, to write a final chapter on coal fields, production, and reserves of the world, but inasmuch as he was unable to do this, the editors decided to omit such a chapter. It is the only deficiency that the reviewer could detect and, perhaps, is better left out because of its statistical and, for the most part, short-lived value.

The line drawings and photographs are excellent and stimulating.

A. J. Eardley

OUTLINES OF STRUCTURAL GEOLOGY, by E. Sherbon Hills, Lecturer in the University of Melbourne, published by Nordeman Publishing Company, Inc., New York, 1940. Price $2.25.

The author has aimed to present a brief, yet reasonably complete and well-documented summary of structural geology with special reference to those aspects of the subject with which the field geologist should be acquainted. The book is small ($4\frac{3}{4}\times 7\frac{1}{4}$ inches) with 172 pages including author and subject indexes. It contains the following chapter headings:

I.	Non-diastrophic structures	20 pages
II.	Rock deformation: Mechanical principles	24 pages
III.	Major crustal structures	25 pages
IV.	Folds	35 pages
V.	Faults	22 pages
VI.	Structures of igneous rocks	18 pages
VII.	Petrofabric analysis	16 pages

The subject of structural geology is defined and limited about as is done in the United States. Under non-diastrophic structures, the field of structural geology that merges with sedimentation, he has properly limited himself to an explanation of the uses of primary sedimentary structures in determining position of beds, and in discussing compaction, slump, slide, and collapse structures.

The second chapter, on the mechanical principles of rock deformation, is a skillful presentation of stress and strain analysis, experimental deformation of rocks, and the meaning of plasticity and flow in rocks. The illustrations are new and instructive. The experimental and analytical data are nicely correlated with field observations. This chapter is up-to-date and much better, in the reviewer's opinion, than any similar one appearing in American texts.

A complete reversal of procedure in the teaching of structural geology is introduced in the third chapter. Here the major crustal structures, or tectonic elements, are presented along with brief but meaty expositions of their origin. Then follow chapters in detailed structural studies. Joints and cleavage are treated under folds. The reviewer looks upon this procedure as an interesting experiment but doubts that most instructors with the general run of undergraduates would do well with it.

Deserved emphasis is given in the next chapter to internal structures of igneous rocks. It appears to be an excellent short discussion for students.

The last chapter on petrofabric analysis is authoritatively up-to-date and very well written and illustrated. The reviewer believes that the undergraduate in American universities would have a difficult time with it, but that it will furnish a good introduction to the subject for graduate students.

The book seems to break a tradition of American texts of partiality to certain aspects of structural geology, or of overemphasis of trivialities that are of minor importance in actual field work. The survey of German, English, and American literature, and the selection and emphasis of subject matter is very pleasing to the reviewer. It seems remarkable in a book so small.

As a text for use in the United States it is not particularly well suited for three reasons. Part of the material is a little too difficult for most undergraduates. There is a deficiency in the practical side of the subject—no problems, little geometry of faults and folds and nothing on structure maps. In short, no laboratory work is suggested or outlined. Many examples are foreign, and in the United States instructors would like more attention given to our own structural provinces or structural types.

A. J. Eardley

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

The Academy of Natural Sciences of Philadelphia, September 5, 1940

Dr. W. Hersey Thomas presided; 49 members and visitors were present. Reports of summer trips included the following: Mr. Morgan visited Herkimer County (quartz crystals); Redstone, N.H. (smoky quartz crystals); Newry, Me. (triphylite and purpurite); Deer Hill, Me. (amethyst); Slope Mountain, N.H. (fluorescent fluorite); Mt. Mica, Me. (tourmaline); Conway, N.H. (feldspar crystals); Grafton, N.H. (autunite); and New Egypt, N.H. (vivianite). Mr. Myers reported jasper from Vera Cruz, Pa., and green tourmaline from Strickland's quarry and Haddam, Conn. Mr. Baldwin and Mr. Toothaker described a trip to Prospect Park, N.J. (prehnite and calcite); Bedford, N.Y. (rose quartz); Andrews's quarry, Glastonbury, Conn. (torbernite); Strickland's quarry, Conn. (apatite, tourmaline); and Summit, N.J. (prehnite). Mr. Evans brought back tourmaline and triphylite from Newry, Me. Mr. Evanoff found malachite at Bridgeport, Pa., uraninite at Avondale, and prehnite at Prospect Park. Messrs. Knabe and Lee visited Franklin, N.J., and Perkiomenville. Mr. Cope exhibited quartz crystals from Culver Lake, N.J. Mr. Flack collected asbestos and molybdenite at Easton, Pa. Mr. Lee found spinel, chondrodite, and phlogopite at Sparta, N.J.

October 7, 1940

Dr. Thomas in the chair, with 94 members and visitors present. The following officers were elected: President, Dr. W. Hersey Thomas; Vice-President, Dr. J. F. T. Berliner; Secretary, Forrest Lenker; Treasurer, Wiley Flack; Councilor, Harold Arndt. Mr. Samuel G. Gordon described a trip to the northwestern states and illustrated his talk with Kodachrome slides, and specimens.

November 7, 1940

Dr. Thomas presided, with 64 members present. Messrs. Darwood Taylor, Harold Saunders, Harold Saunders, Jr., Paul Seel, and Joseph Gruver were elected to membership. Dr. A. Henry Fretz described "The Bethlehem Incident in the History of the Hope Blue Diamond."

FORREST LENKER, *Secretary*

NEW MINERAL NAMES

Armenite

HENRICH NEUMANN: Armenite, a new mineral. Preliminary note. *Norsk. Geol. Tidsskrift*, **19,** 312–313 (1939).

NAME: Named for the Armen mine.

CHEMICAL PROPERTIES: The composition is $BaCa_2Al_6Si_8O_{28} \cdot 2H_2O$. No analysis is given.

CRYSTALLOGRAPHIC PROPERTIES: Pseudo-hexagonal, prismatic (orthorhombic?).

PHYSICAL PROPERTIES: Colorless. Sp. gr$=2.77$. H$=7$–8. $\alpha=1.551$, $\beta=1.559$; 2V 60°, negative. Three cleavages.

OCCURRENCE: Found on a specimen collected in 1877 from the silver-bearing calcite veins of the Armen mine near Kongsberg, Norway. Associated minerals are axinite, pyrrhotite and quartz.

M. FLEISCHER

Seyrigite

ALFRED LACROIX: Les gisements de phlogopite de l'extreme-sud de Madagascar: *Compt. Rendu Acad. Sci., Paris* **210,** 273–276 (1940).

NAME: for Mr. Seyrig, operator of the phlogopite mine.

CHEMICAL PROPERTIES: $Ca(W,Mo)O_4$, a member of the scheelite-powellite series. Analysis gave 24.01% MoO_3.

PHYSICAL PROPERTIES: Color yellow-gold, translucent. Sp. gr.$=5.484$. Tetragonal. Uniaxial, positive.

OCCURRENCE: Found in the weathered zone in broken crystal fragments up to 7 cm. across, associated with quartz, opal, phlogopite and sepiolite. In the unweathered zone, enormous crystals of phlogopite, diopside, allanite, sphene and apatite are found.

DISCUSSION: An unnecessary name.

M. F.

NEW DATA

Bassetite

HEINZ MEIXNER: Fluoreszenzanalytische, optische und chemische beobachtungen an uranmineralen: *Chem. der Erde*, **12,** 433–450 (1939–40).

Microchemical tests showed that bassetite, which has never been analyzed but which was supposed to be dimorphous with autunite, contains no calcium. Good tests were obtained for uranium, phosphorus and ferrous iron. The composition is probably $Fe(UO_2)_2(PO_4)_2 \cdot nH_2O$. Bassetite does not fluoresce in ultraviolet light (difference from autunite).

M. F.

DISCREDITED MINERALS

Lapparentite (of Ungemach) = Tamarugite

The identity of lapparentite with tamarugite. Samuel G. Gordon. *Notulae Naturae Acad. Nat. Sci. Philadelphia*, no. **57,** Sept. 1940. Lapparentite, described by Ungemach (*Bull. Soc. franc. Min.*, **58,** 209–213 (1935), is tamarugite, $NaAl(SO_4)_2 \cdot 6H_2O$. Crystallographic data on material from 6 Chilean localities agree closely with Ungemach's crystallographic constants for lapparentite from Chile. The refractive indices also agree closely, likewise the specific gravities. Ungemach's analysis, which gave the formula $Al_2O_3 \cdot 2SO_3 \cdot 10H_2O$, must have been erroneous.

Discussion: Gordon's description leaves no doubt as to the identity of Ungemach's lapparentite with tamarugite. However, Rost (*Rozpravy Ceske Ak.*, Kl. II, **47,** no. 11, 1937), *N. Jb. Min.*, Ref. **I,** p. 360 (1938), referred to lapparentite a mineral which is not tamarugite. Its properties are:—

Crystallographic Properties: Small tablets with rhombic outlines and diagonal extinction.

Chemical Properties: Analysis gave SO_3 35.51, Al_2O_3 22.07, MgO 0.52, Na_2O 1.09, H_2O 40.69; sum 99.69, corresponding to $Al_2O_3 \cdot 2SO_3 \cdot 10H_2O$.

Physical Properties: Sp. gr. = 1.892 (for tamarugite, sp. gr. = 2.07). Refractive indices of material from two localities: $\alpha = 1.460$, 1.461; $\beta = 1.470$, 1.470; $\gamma = 1.482$, 1.484. Optically positive, acute bisectrix perpendicular to the tabular face.

Occurrence: Found associated with tschermigite at Libusin near Kladno, Czechoslovakia; formed during the burning of a coal-mine dump. Also reported from Wackerdorf, Germany, also from burning dumps.

Perhaps the name lapparentite should be transferred to this material.

M. F.

Teaching Fellowship in Mineralogy

A teaching fellowship in mineralogy has been established at Stanford University. The fellowship is open to graduate students who intend to specialize in mineralogy, and preference will be given to those who have had one or two years of graduate work. The chief duty of the fellow is to assist in laboratory instruction. Not more than eight or nine hours a week will be required. The amount of the fellowship is $750.

Application for the year 1941–42, supported by testimonial letters should be made to Professor Austin F. Rogers, Box 87, Stanford University, California.